THE

PRINCIPLES AND PRACTICE

OF

DENTISTRY.

FIFTH EDITION.

HARRIS. Dictionary of Dentistry. Including Definitions of such Words and Phrases of the Collateral Sciences as Pertain to the Art and Practice of Dentistry. Rewritten, Revised, and Enlarged by FERDINAND J. S. GORGAS, M.D., D.D.S., Author of "Dental Medicine;" Editor of Harris's "Principles and Practice of Dentistry;" Professor of Principles of Dental Science, Dental Surgery, and Prosthetic Dentistry in the University of Maryland. Octavo. Cloth, $4.50; Leather, $5.50

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THE PRINCIPLES AND PRACTICE OF DENTISTRY

INCLUDING

ANATOMY, PHYSIOLOGY, PATHOLOGY, THERAPEUTICS, DENTAL SURGERY AND MECHANISM.

BY

CHAPIN A. HARRIS, M.D., D.D.S.,

LATE PRESIDENT OF THE BALTIMORE MEDICAL COLLEGE, AUTHOR OF "DICTIONARY OF MEDICAL TERMINOLOGY AND DENTAL SURGERY."

Thirteenth Edition.

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EDITOR'S PREFACE

TO THE

THIRTEENTH EDITION.

THE continued demand for, as well as the exhaustion of, the twelfth edition of this well-known and universally used text-book, has stimulated the author to prepare a new edition with the care demanded by a due consideration of the needs of the dental practitioner and student.

In the preparation of this new edition, every chapter of the entire work has been carefully revised, and, with few exceptions, important additions made to all of them.

By omitting considerable matter that was either obsolete, or more properly belonged to works treating of special as well as kindred sciences, this new edition has been somewhat abridged as to the number of pages, and thereby prevented from becoming unwieldy. In the anatomical portion it was deemed necessary to add to the description of the bones of the jaws that of the entire skull. Many new processes appear in the new edition, and the already large number of illustrations has been greatly increased. Special care has been taken to mention the latest methods for constructing crown- and bridge-work and artificial dentures, and the most approved systems for correcting irregularity of the teeth, fractures of the jaws, etc., etc. Many chapters have been re-written, and the entire work brought up to the present advanced standard of dentistry in all its branches. The author, therefore, presents this new edition in the belief that it will prove to be more useful even than its predecessors, and meet the requirements expected of a text-book on such subjects as it comprises.

FERDINAND J. S. GORGAS.

HAMILTON TERRACE, BALTIMORE, MD., 1895.

EDITOR'S PREFACE

TO THE

TWELFTH EDITION.

THE reputation and success of this text-book as an elementary treatise on the principles and practice of dentistry have been so apparent, and so universally recognized for many years by the practitioner and student, that no words of commendation on our part need be said. It has reached every civilized country and been translated into several languages.

The rapid advance of dental science, without a parallel when compared with that of other professions, has necessitated repeated additions, until the present volume has attained a size greatly above any that has preceded it.

In presenting the twelfth edition, it is with the hope that the efforts made to render the work such that it may receive the kind approval so generally bestowed upon the editions that have preceded it may be appreciated by those for whose benefit it has been prepared. It is an encouraging fact that the eleventh edition was exhausted some months before the present one was ready to be issued.

Additions have been made to almost every chapter, and new matter added to such an extent that this new edition contains, notwithstanding omissions deemed necessary, some *two hundred and twenty-six pages* more than its immediate predecessor. *Three hundred and eighty-two* new illustrations have also been added and considerable changes made in the general arrangement of subjects, all of which it is hoped will increase its value as a text-book.

A number of systems not before published in works of this character appear in the present volume, and every effort has been made to sustain the reputation heretofore accorded to it by the dental profession.

The editor and publishers are under many obligations to dental practitioners of recognized ability and reputation for systems of practice of which they are the authors; and also to the S. S. White Dental Manufacturing Company, the Welch Dental Company, Samuel A. Crocker & Company, through whose courtesy many of the valuable wood-cuts which appear in the present volume were furnished, and which greatly add to its value as a text-book.

FERDINAND J. S. GORGAS.

HAMILTON TERRACE, BALTIMORE, MD.,
February 1, 1889.

EDITOR'S PREFACE

TO THE

ELEVENTH EDITION.

THE first edition of Chapin A. Harris's "Principles and Practice of Dentistry" was published in 1841, and from that date it has been the principal text-book in all dental schools.

The last or tenth revision was issued under the careful supervision of the late Professor Philip H. Austen, M.D., D.D.S., assisted, in the parts relating to anatomy and physiology, by Dr. Thomas S. Latimer, and in parts relating to pathology and surgery, by the editor of the present edition. As the ten years prior to this revision had nearly revolutionized dental mechanism, Professor Austen found it necessary to almost re-write the portion of the work relating to "Mechanics," and its superior excellence was universally acknowledged.

Nearly fourteen years having elapsed since this was done, the rapid advances made during this period in Dental Histology, Pathology, Surgery, and also to a considerable degree in Mechanism, have necessitated another revision, and at the request of the author's family and of the publishers, the editor has alone undertaken the task of revision, and the present edition is the result of more than a year's labor. This duty has been assumed with the hope that an experience of over a quarter of a century as a teacher in dental schools, and also as a dental practitioner, may have furnished the qualifications for such an undertaking.

The time which has elapsed since the first appearance of the tenth

edition has necessitated a greater revision of this work than has been the case with any former edition, and the task of preparing an entirely new work would have been no greater.

Considerable changes have been made in the general arrangement of subjects; a number of entirely new chapters have been added in the consideration of subjects not even alluded to in former editions; additions have also been made to the text of nearly every chapter, some of the latter being far in excess of the original text.

The number of illustrations has been greatly increased, and the new matter now inserted has brought the work fully up to the time of its publication.

Obsolete theories and processes, together with unimportant details, have been omitted and more useful matter substituted. The aim of the editor has been to meet the demands of the present advanced state of dental science.

The new matter added includes: The Development of the Bones of the Head and Face; Temporo-Maxillary Articulation; Description of Mucous Membrane; The Origin and Development of the Teeth; Analysis of Tooth Structures; Secondary Dentine; Dentition; Calcification and Decalcification of the Teeth; Alveolar Pyorrhea; Aphthous Stomatitis; Thrush; Sanguinary Calculus; Malformed Teeth; Effects of Syphilis upon the Dental Structures; Caries of the Maxillary Bones; Sensitive Dentine; Theories as to the Cause of Dental Caries; Treatment of Dental Caries; New Methods, Materials, and Instruments Employed in Filling Teeth and other Operations; Electric Mouth Lamp; Electric Mallet; Dental Engines and Attachments; Rubber Dam Appliances; Treatment and Appliances for Correcting Irregularity of the Teeth; Contour Fillings; Replantation and Transplantation of Teeth; Different Methods of Inserting Artificial Crowns on Natural Roots; Bridge-Work; General and Local Anesthetic Agents; Improved Forceps; New Materials and Trays for Impressions; Articulators; Blowpipes; Furnaces; Celluloid; New Apparatus for Vulcanizing Rubber and Molding Celluloid; Repairing Vulcanite; Duplicating Dentures; Theory of Vulcanizing; Regulators; Gold Alloy and other Cast Bases; Temperament in Relation to Natural and Artificial Teeth;

Improvements in Porcelain Teeth; New Splints for Fracture of the Jaws, etc., etc., etc.

The editor desires to acknowledge his indebtedness to Drs. George B. Snow, James H. Harris, Charles L. Steel, W. Storer How, and D. Genese, for valuable suggestions; and also to the writings of Drs. James W. White, Frank Abbott, J. Foster Flagg, John Tomes, Charles Tomes, Henry Sewell, Henry W. Williams, C. N. Peirce, W. D. Miller, G. V. Black, George Watt, J. L. Williams, James B. Dexter, Norman W. Kingsley, Theo. F. Chupein, J. N. Farrar, W. C. Barrett, J. D. Hutchinson, W. G. A. Bonwill, A. W. Harlan, C. T. Stockwell, the late M. A. Dean, M. H. Webb, and others. The courtesy of The S. S. White Dental Manufacturing Company, Johnson & Lund, Snowden & Cowman, Codman & Shurtleff, The Buffalo Dental Manufacturing Company, Spencer & Crocker, Ransom & Randolph, Gideon Sibley, and Dr. Norman W. Kingsley, is acknowledged, for the use of many valuable wood-cuts.

The Eleventh Edition of Harris's "Principles and Practice of Dentistry" is submitted to the profession, with a hope that it will be found a useful elementary treatise, a text-book for the student, and a reliable guide for the dental practitioner.

FERDINAND J. S. GORGAS.

BALTIMORE, *January, 1885.*

PREFACE TO THE SECOND EDITION.

In submitting to the profession a Second Edition of his Dental Practice, the author is happy to avail himself of the opportunity to express his grateful appreciation of the approbation which the First has received. He trusts that the additions which he has made to the primary work will make the one now presented still more acceptable. The alteration in the plan, which has resulted from the effort at improvement, has, however, rendered a slight change of title necessary, in order to express the character of the present book.

In the First Edition the Anatomy of the Mouth was omitted, because a thorough knowledge of it can be obtained from works on General Anatomy. But it has been suggested that such works may not be at hand when wanted by the dental student, and the author has thought it better to furnish a description of the several structures which enter into the formation of this cavity. He has, however, confined himself to brief expositions of the parts; not wishing to encumber the work, or distract the student with the consideration of matters foreign to the purpose for which it was written, and for which, he trusts, it will be read. He is indebted to Bourgery's Anatomy, Quain and Wilson's Anatomical Plates, Wilson's Anatomy, and Smith and Horner's Anatomical Atlas, for a number of the illustrations used in this part of the work.

The Second and Fifth Parts embody the substance of two papers by the author, which were written subsequently to the publication of the First Edition. The subjects of them came properly within the plan of the present work.

The object of the author in the preparation of this edition has been to provide a thorough elementary treatise on Dental Medicine and Surgery, which might be a text-book for the student and a guide to the more experienced practitioner; and he hopes that the modifications he has introduced, and the additions he has made, will entitle it to be so considered, at least, until an abler hand shall prepare a better.

Chapin A. Harris, M.D., D.D.S.

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THE

PRINCIPLES AND PRACTICE

OF

DENTISTRY.

CHAPTER I.

ANATOMY AND PHYSIOLOGY OF THE MOUTH.

THE mouth (*oral or buccal cavity*) is the entrance to the alimentary canal, and in the human subject signifies the space included between the palatine arch *above*, the mylo-hyoid muscles *beneath*, the lips in *front*, the soft palate and fauces *behind*, and the cheeks on *either side*. The teeth and closed jaws separate the inner portion, or lingual cavity, from the outer, or vestibular space.

The form of the mouth is nearly oval, and it is lined with mucous membrane, which is continuous with the integument at the free margin of the lips, and with the same membrane lining the fauces behind. The mucous membrane of the mouth is naturally of a rose-pink tinge, covered by stratified epithelium, and variable in thickness, being very thick where it covers the hard parts bounding this cavity.

In the mouth are the tongue, teeth, and the alveolar ridges invested by the gums; into it are poured the secretion of the parotid, sub-maxillary, and sublingual glands, as well as that of the ordinary mucous and of the special lingual follicles; and in it the food is subjected to the processes of mastication and insalivation previous to deglutition.

It is further concerned in the prehension of aliment; and besides containing the organs of taste, is employed in articulation, expectoration, suction, etc.

The parts concurring to constitute the mouth form a very complicated piece of mechanism; through them it has a wide range of sympathies, and by them it performs a great variety of functions.

The anatomical elements composing these parts consist of Bone, Ligament, Muscle, Gland, Blood-vessel, Nerve, Areolar and Adipose tissues, and Mucous membrane.

These different elements combine together and form the various organs which constitute the mouth.

These organs will be considered in their physiological order; thus combining their anatomy and physiology, studying at the same time both their healthy structure and function.

CHAPTER II.

OSTEOLOGY.

Bone is one of the hardest substances in the body, and is endowed with a certain degree of toughness and elasticity. Its natural color is pinkish-white externally and red internally. It is composed of animal, or organic, matter, in intimate association with earthy, or inorganic, matter. From the organic matter the bone derives the properties of toughness and elasticity; and from the earthy material, hardness and solidity. The mineral matter may be dissolved out by a dilute solution of nitric or muriatic acids, while the animal matter remains unaffected, retaining its form, though losing its hardness, so that the long bones, so great is their flexibility, may be tied into a knot; on the other hand, by subjecting them to a high heat in an open fire, while exposed to the air, the animal matter may be consumed, leaving the mineral to preserve the form of the bone, but so insecurely that it will crumble to ashes in the grasp of the hand.

The composition of bone, according to Berzelius, is about one-third animal and two-thirds mineral matter:—

Organic, or Animal, Matter,	Gelatin and Blood-vessels,	33.30
Inorganic, or Earthy, Matter.	Phosphate of Lime,	51.04
	Carbonate of Lime,	11.30
	Fluorid of Calcium,	2.00
	Phosphate of Magnesia,	1.16
	Soda and Chlorid of Sodium,	1.20

The proportion of earthy and animal matter is generally thought

to vary with varying age. According to Shreger, this difference is as follows:—

	Child.	*Adult.*	*Old Age.*
Animal Matter, ...	47.20	20.18	12.2
Earthy Matter, ...	48.48	74.84	84.1

In childhood, when the animal matter is in excess, the bones, on account of injury, may become bent or partially fractured; whereas in old age, the earthy matter being in excess, the bones are more brittle and fracture more easily.

The local position of bone is first occupied by a mucoid (mucous-like) substance which is transformed into temporary cartilage (*blastema*) during the second month of fetal life. The young bone-cells (*osteoblasts*) are then deposited in the cartilage at certain points, and their deposition and subsequent pressure cause the absorption of the cartilage. This is the form of ossification described as *intracartilaginous*.

In the second form of ossification, described as *intramembranous*, no temporary cartilage (or cartilage mold) precedes the appearance of the bone-tissue. The bones of the vertex of the skull are entirely formed by intramembranous ossification. In the local position of the bone about to be formed, a little network of osseous spiculæ first appears radiating from the point of ossification, which under the microscope consists of fine, clear fibres and granular corpuscles, with an intermediate ground-substance. These fine fibres are termed *osteogenic* fibres, which soon become dark and granular from calcification, and as they calcify they enclose the bone-cells (*osteoblasts*). The calcification includes both the fibres and intermediate or ground-substance in which the former are contained. The number of ossific centers differs: In the long bones there is a central point of ossification for the shaft and one for each extremity.

Bone is composed of an outer compact layer, and an inner cellular or spongy structure, and is surrounded, except at the articular cartilages, by a vascular fibrous membrane termed the *Periosteum*, which envelops the bone and receives the insertions of all tendons, ligaments, etc. The central cavity of the long bones is lined by a structure similar to the periosteum, known as the *Endosteum*.

The Haversian Canals are tunnels in the compact substance of the bone which contain the blood vessels. Whenever the bone is so thin as to be able to derive its nutrition from the vascular membrane covering its surface, there are no Haversian canals in it, as none are required. Such bones, however, have numerous lacunæ, which send out canaliculi to open on the surface and imbibe the requisite nutrition.

The Haversian canals vary in diameter from $\frac{1}{1000}$ to $\frac{1}{200}$ of an inch,

the average being $\frac{1}{500}$. The smallest are found near the outer surface, where the bone is the most compact, but they gradually become larger toward the interior, where they open out into the spongy or cancellous tissue or into the medullary cavity. The smaller canals contain only a single capillary blood-vessel; the larger contain a network of vessels, while the largest, which gradually merge into the cancellous tissue, contain marrow as well as blood-vessels.

The Lacunæ are the irregular hollow cavities or spaces between the lamellæ, arranged in concentric circles around the Haversian canals. They are characteristic of true bone, and each lacuna contains a soft nucleated substance termed bone corpuscle, which sends its soft processes along the canaliculi. The bodies in the lacunæ and canaliculi circulate nutritious matter through the bone. The lacunæ are commonly oval and flattened, so that one of their broad sides is turned toward the Haversian canal. The lacunæ measure about $\frac{1}{2000}$ of an inch in their long diameter, and about $\frac{1}{6000}$ in their short. *The Canaliculi* are exceedingly minute canals which in their course cross the lamellæ and connect the lacunæ with each other and also with the Haversian Canal. They run off from all parts of the circumference of the lacunæ and communicate most freely with the canaliculi of the adjoining lacunæ. Their diameter ranges from $\frac{1}{14000}$ of an inch to $\frac{1}{20000}$ of an inch, but some are even smaller.

The Lamellæ are the concentric thin plates of bone tissue encircling the Haversian Canal, and result from successive layers of bone being deposited around the Haversian vessel, the one within the other; a process which renders the bone more dense in structure.

CHAPTER III.

BONES OF THE HEAD AND FACE.

Although most of the bones of the human body pre-exist in the shape of cartilage, there are some which are directly formed in membrane, namely, such bones of the skull as the frontal, parietal, the upper half of the occipital, the squamous and tympanic parts of the temporal; also the bones of the face, and the inner plate of the pterygoid process of the sphenoid bone. In fact, none of the bones of the skull pre-exist as cartilage, except those which form the base of the skull. The bones of the head are twenty-two in number, of which eight compose the cranium and fourteen the face. Those of the cranium are one frontal, two parietal, two temporal, one occipital,

one sphenoid, and one ethmoid. Those of the face are six pairs and two single bones; the pairs are the two malar, two superior maxillary, two lachrymal, two nasal, two palatine, and two inferior turbinated. The vomer and inferior maxillary are the two single bones.

Development of the Bones of the Head and Face.—The first definite form which is developed in the embryo is that of the rudimentary spinal column, its earliest trace being a faint streak, which is known as the *primitive trace* or *groove*. This groove deepens into a furrow, which is bounded by two plates, beneath which a delicate fibril appears, called the *chorda dorsalis*, or *notochord*, in which cartilage is very early developed.

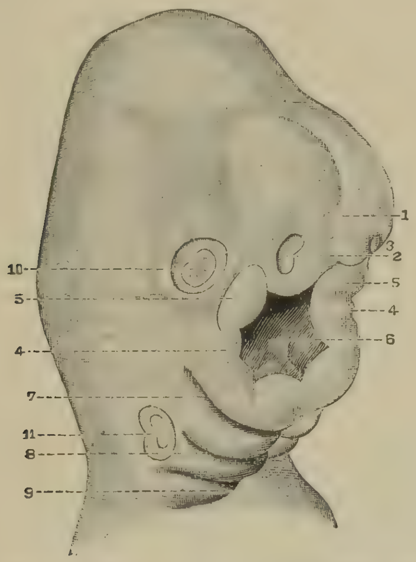

FIG. 1.—FACE OF AN EMBRYO OF 25 TO 28 DAYS. (MAGNIFIED 15 TIMES.)
1. Frontal prominence. 2, 3. Right and left olfactory fossæ. 4. Inferior maxillary tubercles, united in the middle line. 5. Superior maxillary tubercles. 6. Mouth or fauces. 7. Second pharyngeal arch. 8. Third. 9. Fourth. 10. Primitive ocular vesicle. 11. Primitive auditory vesicle.

The upper end of the chorda dorsalis terminates in a pointed extremity extending as far forward as the sphenoid bone.

The embryonal cranium is developed from the primitive vertebral discs, which surround the upper extremity of the chorda dorsalis. These discs advance in the form of a membranous capsule, which molds itself on the cerebral vesicles, so as to constitute the membrane in which the vault of the skull is developed, and which is replaced by cartilage in the part corresponding to the base of the skull. A portion of this primitive cartilaginous cranium atrophies and disappears, while another portion remains and forms the car-

tilages of the nose and the articulations, the basilar part of the occipital, the greater part of the sphenoid, the petrous and mastoid portions of the temporal, the ethmoid, and the septum nasi.

From the anterior end of the chorda dorsalis the four pharyngeal arches proceed on either side and meet in the middle line.

In these pharyngeal arches the secondary bones are developed, so called to distinguish them from those already referred to, which are formed from the primitive cranium itself. The buccal depression, which afterward becomes the cavity of the mouth, or rather the fauces, is situated between the first pharyngeal arch and the frontal protuberance.

The first pharyngeal arch divides at its anterior extremity into two parts—a superior and inferior maxillary protuberance, the inferior maxillary uniting very early to the corresponding one of the opposite side, to form the lower jaw.

The superior maxillary protuberances are united to the external nasal process, and the palate bone, the superior maxillary, the malar, and also the internal plate of the pterygoid process are developed from this process. From the internal nasal process, the nasal bones, the lateral portions of the ethmoid, and the os unguis are developed. From the incisive tubercle or process, which unites the rest of these processes on either side, and which grows downward from the frontal prominence, filling in the space between the extremities of the two processes which proceed from the first pharyngeal arch, the intermaxillary bone, the middle of the upper lip, and the vomer are formed. When the middle and two lateral processes fail to unite, the deformity known as *hare-lip* is caused. From the lateral processes of the superior maxilla the plates which form the hard palate grow toward each other, union occurring in the median line. This union of the plates separates the nose from the buccal cavity, and is generally completed at the end of the second month. Prior to this union of the plates by their complete development, the nose and buccal cavity form but one cavity; and when this union does not take place the deformity known as *cleft-palate* results. Cleft-palate often accompanies hare-lip, as the causes which produce the latter deformity, during the development of the intermaxillary bones, may prevent the natural development of the palate bones.

At an early period of embryonal life the inferior maxillary arch, which also arises from the first pharyngeal arch, is altogether destitute of any trace of osseous tissue, but it encloses within the elements composing it a symmetrical cartilaginous band, which performs a transitory part only in the development of the jaw.

This band is called "Meckel's Cartilage," and it occupies the

interior of the maxillary arch, having the form of a whitish cord situated in a bed of soft transparent tissue, and is composed of two symmetrical parts corresponding to the right and left sides of the lower jaw, which parts soon become united at the mental symphysis. From this point or juncture the two halves extend on either side to the bones of the ear, terminating in the malleus, which, with the incus, is formed from it.

Meckel's cartilage gives form and stability to the lower jaw of the embryo, and is the first solid structure discovered in the maxillary arch. It first appears about the twenty-fifth day, and during its existence, which extends to the fifth month of fetal life, it is subject to constant modifications or transitory states.

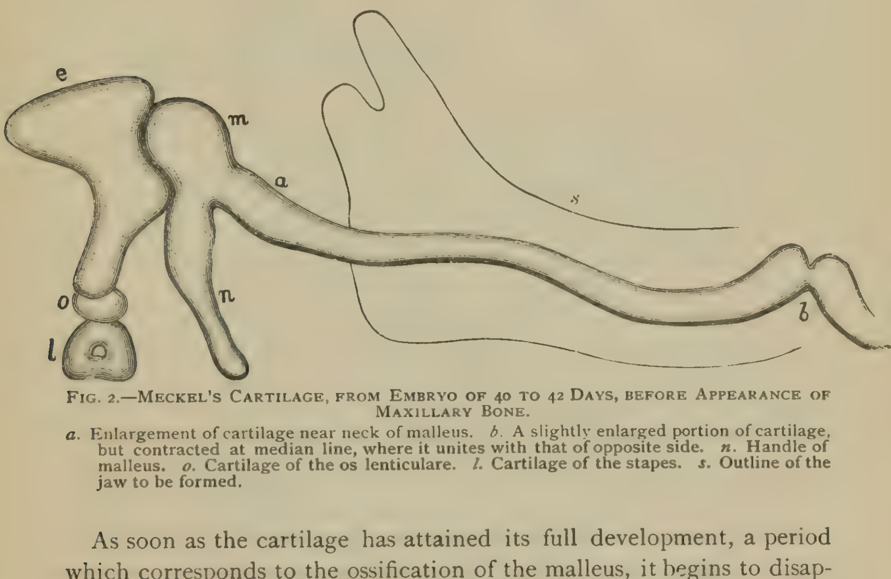

FIG. 2.—MECKEL'S CARTILAGE, FROM EMBRYO OF 40 TO 42 DAYS, BEFORE APPEARANCE OF MAXILLARY BONE.

a. Enlargement of cartilage near neck of malleus. *b*. A slightly enlarged portion of cartilage, but contracted at median line, where it unites with that of opposite side. *n*. Handle of malleus. *o*. Cartilage of the os lenticulare. *l*. Cartilage of the stapes. *s*. Outline of the jaw to be formed.

As soon as the cartilage has attained its full development, a period which corresponds to the ossification of the malleus, it begins to disappear, except the end, which extends up to the tympanum and becomes ossified into the malleus, owing to the action of the osteoblasts by which this cartilage is ossified, and becomes a part of the maxilla.

In the upper jaw the period of evolution corresponds with that of the lower jaw; Meckel's cartilage belongs exclusively to the lower jaw.

At a period between the thirty-fifth and fortieth days of embryonal life, slight traces of ossification are observed at points midway between the angle and symphysis of the future jaw, and the ossification extends rapidly in both directions, anterior and posterior, along the external face of Meckel's cartilage, and in contact but not united with it.

At about the second month of gestation, the rudimentary jaw-bone is formed, but not completed; it is composed of two arches, an internal cartilaginous one, composed of Meckel's cartilage; and an external one, composed of osseous matter; the former being only needed for a time to support the jaw, and the latter the rudiment of the bone of the jaw.

While later in life there are two superior maxillary bones, in early fetal life there exists what are called inter-maxillary bones, the upper jaw during its development being composed of four bones—two maxillary and two inter-maxillary. In each of the two inter-maxillary bones are developed two incisors—a central and a lateral, and in each of the two maxillary bones—a canine and two molars—later a canine, two bicuspids, and three molars. Before birth the intermaxillary and the maxillary bones unite, reducing the number to two instead of four, and the inter-maxillary suture, where the union takes place, can be seen at birth on the palatal surface, but not on the outer surface.

FIG. 3.—FROM HUMAN EMBRYO OF 60 DAYS, NATURAL SIZE.

A. Extra-tympanic portion of Meckel's cartilage. B. Symphysis. N. Handle of malleus.

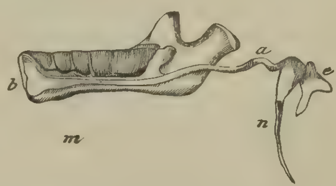

FIG. 4.—INTERNAL FACE OF RIGHT INFERIOR MAXILLA OF EMBRYO OF THREE MONTHS.

a. Extra-tympanic portion. *b*. Symphysis of the cartilage. *n*. Handle of malleus. *e*. Cartilage of incus.

FIG. 5.—FROM FETUS OF FOUR MONTHS, SHOWING INTER-MAXILLARY SUTURE ON PALATAL SURFACE, WHERE THE INTER-MAXILLARY BONES HAVE UNITED WITH THE MAXILLARY BONES.

These inter-maxillary bones are designated by Huxley as *premaxillæ*, and in some animals they remain permanently as separate bones.

The buccal cavity comprises the mouth and nose until a lamina is formed from the superior maxillary tuberosity on either side, which has a horizontal inward direction. The two palatine lamellæ meet in the median line, in front, about the eighth week, and the septum is completed about the ninth week. The superior maxillary bones and the soft parts covering them unite at an early period with the inter-maxillary or incisive bone, and the median portion of the lower lip. The nostrils are formed by the olfactory fossæ opening into the upper or respiratory portion of the cavity.

THE SUPERIOR MAXILLARY BONES.

The *Superior Maxillary Bones*, two in number, are in pairs, and united on the median line of the face. They occupy the anterior upper part of the face, are of very irregular form, and consist of a body and processes. They are the largest bones of the face except the inferior maxilla, and enter into the formation of three cavities, the orbit, the mouth, and the nares; they also enter into the formation of the zygomatic and spheno-maxillary fossæ, and the spheno-maxillary and pterygo-maxillary fissures.

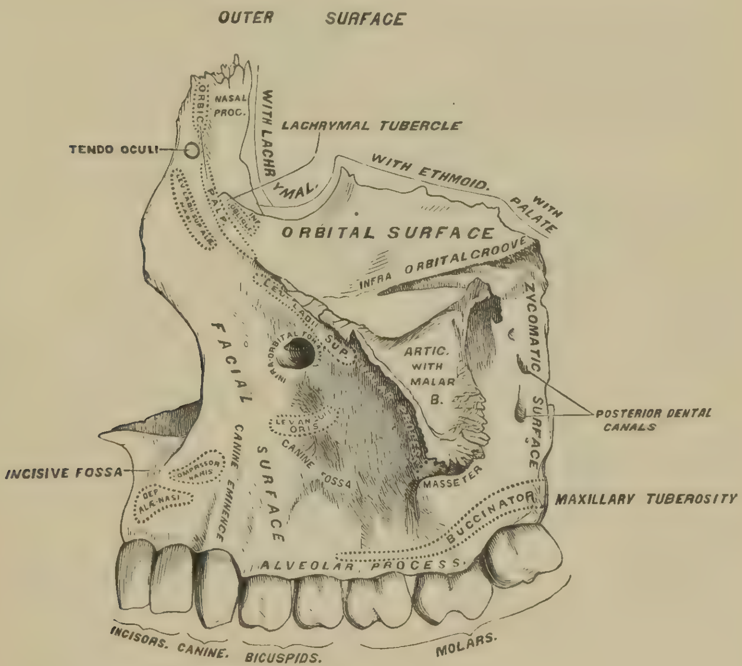

FIG. 6.

The body is the central part of the bone, and has four surfaces; namely, the external or facial, the posterior or zygomatic, the superior or orbital, and the internal or palatine.

The *External Surface* is irregularly convex, and has a depression about its center, just above the canine and first bicuspid teeth, called the canine fossa; immediately above which is the infra-orbital foramen for transmitting an artery and nerve of the same name; its upper and inner edge forms part of the lower margin of the orbit, to which is attached the levator labii superioris proprius muscle.

The *Posterior Surface* has a bulging, called tuberosity, which is connected with the palate bones, and bounds the antrum behind; it is perforated by three or four small holes—the posterior dental canals, which transmit nerves and blood-vessels to the molar teeth. This surface presents also on its nasal face a groove, which becomes, by articulation with the palate bone, the posterior palatine canal.

The *Internal Surface* extends from the alveolar processes in front to the horizontal plate of the palate bones behind, called the palatine processes, which are rough below, forming the roof of the mouth, and

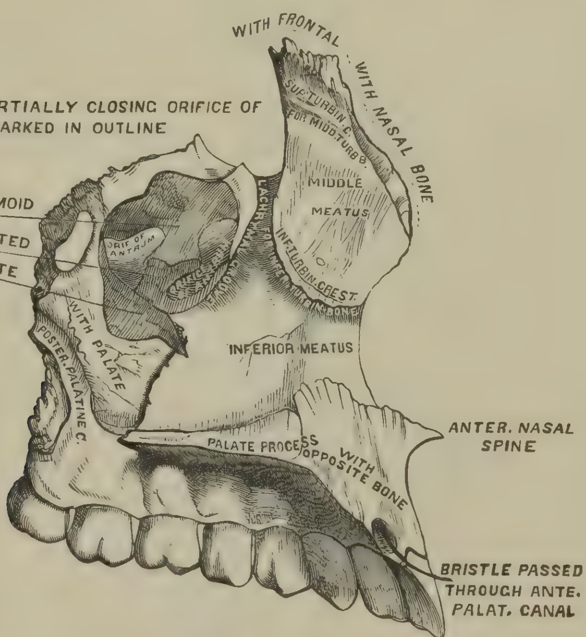

FIG. 7.

smooth above, making the floor of the nostrils. They are united along the median line, at the anterior part of which is the foramen incisivum, having two openings in the nares above, while there is but one in the mouth below. The body of the superior maxilla is occupied by a large and very important cavity called the *Antrum Highmorianum*, or Maxillary Sinus. This cavity is somewhat triangular in shape, with its base generally looking to the nose, and its apex to the malar process. Its upper wall is formed by the floor of the orbit, its lower by the alveoli of the molar teeth, which sometimes perforate this cavity. The canine fossa bounds it in front, while the tuberosity closes it

behind. But the shape of this cavity is exceedingly variable. In examining a collection of nearly one hundred maxillæ in the Dental Department of the University of Maryland, no two sinuses were found to be shaped alike ; and this difference is as marked between the right and the left in the same, as in different subjects. The floor of some is nearly flat, but in the majority of cases it is very uneven ; sometimes crossed by a single septum, varying from one-eighth to half an inch in height ; at other times there are found three or four septa, dividing the lower part of the cavity into as many separate compartments, with the bottom or floor of no two on a level with each other. Some are perforated by the roots of one or more teeth ; at other times the roots of several teeth extend considerably above the level of the floor of the antrum, covered by a lamina of bone scarcely thicker than bank-note paper. In other cases, the floor of the antrum is half an inch above the extremities of the roots of the teeth. This cavity also varies as much in size as it does in shape.

The opening of the antrum is, on its nasal portion or base, into the middle meatus of the nose ; in the skeleton it is large, while in the natural state it is much contracted by the ethmoid bone above, the inferior turbinated bone below, the palate bone behind, and by the mucous membrane which passes through the opening and lines the interior of the antrum. A deep groove lies in front of the opening in the antrum, which is converted into a canal for the nasal duct by the lachrymal and inferior turbinated bones.

The *Malar Process* is a rough, triangular process, marking the boundary between the external and internal surfaces. It presents on its upper margin a roughened surface for articulation with the malar bone.

The *Nasal Process* forms the lateral boundary of the nose. It is a thick, triangular prominence articulating at its upper extremity, by a serrated edge, with the frontal bone, and, by an uneven surface, with the ethmoid bone ; a little lower on its internal surface it offers a transverse ridge, the superior turbinated crest, for articulation with the middle turbinated bone ; below this is the inferior turbinated crest, to which is attached the inferior turbinated bone ; and lying between these crests is a smooth, concave space, forming part of the middle meatus, while beneath the inferior crest is a like space which forms part of the inferior meatus. By its anterior border it is articulated with the nasal bone, and by its posterior with the lachrymal bone, forming with it the canal for the nasal duct, while at the junction of the anterior lip of the nasal groove with the orbital surface is placed the lachrymal tubercle, serving as a guide to the duct in all operations for fistula lachrymalis.

The *Alveolar Process* is formed on the lower edge of the external surface; it is broader behind than in front, and is perforated with excavations corresponding in number with the teeth; those depressions which receive the teeth of more than one root are subdivided by bony septa into compartments of a sufficient number to receive these roots.

The bottom of each of these cavities is perforated by a small foramen, for the passage of nerves and blood-vessels which supply the teeth. The alveolar border externally presents a fluted appearance; the projections correspond with the alveolar cavities, and the depressions with the septa which divide them from one another.

FIG. 8.

The *Palate Process* forms the roof of the mouth and part of the floor of the nose; it is thick and strong, and presents in front the orifice of the anterior palatine canal through which passes the anterior palatine vessels, whilst the inferior naso-palatine nerves pass along the inter-maxillary suture. The inferior surface at the back part has a deep groove, sometimes a canal, for the passage of the posterior palatine vessels, and a nerve of large size; it is also perforated with numerous foramina for the passage of nutrient vessels. The outer border is closely attached to the rest of the bone. The inner border, thicker in front than behind, presents a ridge, which, together with a similar ridge on the opposite bone, forms a groove in which the vomer is received. The anterior margin is prolonged into a sharp process, the nasal spine. By its posterior border it articulates with the horizontal plate of the palate bone.

The structure of the upper jaw, with its alveolar and numerous other processes, is thick and cellular; the cancellated structure being invested with a thin layer of compact bone.

It is articulated with two bones of the cranium, the frontal and ethmoid, and seven of the face, namely: the nasal, malar, lachrymal, palate, inferior turbinated, vomer, and to its fellow, by sutures; also to the teeth by the articulation termed *gomphosis*.

Its development commences at so early a period of intra-uterine life, and ossification proceeds so rapidly, that the number of ossific centers is uncertain; some give a center for the body and each process, others think that most probably there are but four centers in all. It may be seen as early as the thirty-fifth or fortieth day after concep-

tion ; and although at birth it has acquired but little height, it has increased considerably in breadth. But at this period the alveolar border, which constitutes the largest portion of the bone, is almost in contact with the orbit. The antrum is still scarcely perceptible, but as the vertical dimensions of the bone are increased, it is gradually developed. With the loss of the teeth, the alveolar border nearly disappears, so that the vault of the palate loses its arched form, and sometimes becomes almost flat.

The *Upper* or *Orbital Surface* is triangular in shape, with its base in front forming the anterior, lower, and internal edges of the orbit, while its apex extends back to the bottom, forming the floor of the orbit and roof of the antrum ; its internal edge is united to the lachrymal, ethmoid, and palate bones ; its external edge assists in forming the spheno-maxillary fissure, and along its central surface is seen a canal running from behind, forward and inward—the infra-orbital canal. This canal divides into two ; the smaller is the *anterior dental*, which descends to the anterior alveoli along the front wall of the antrum ; the other is the proper continuation of the canal, and ends at the infra-orbital foramen.

THE INFERIOR MAXILLARY BONE.

The *Inferior Maxillary Bone* (Fig. 9) is the largest bone of the face,

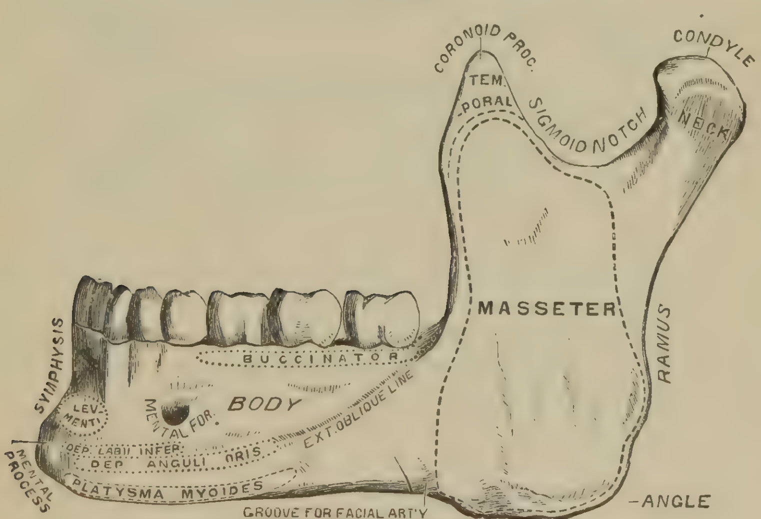

FIG. 9.

and though single in the adult, it consists of two symmetrical pieces in the fetus, which become joined at the symphysis in the first year.

It occupies the lower part of the face, has a parabolic form, and extends backward to the base of the skull.

It is divided into a body and extremities.

The body is the middle and horizontal portion ; this is divided along its center by a ridge called the *symphysis*, which is the place of separation in the infant state ; the middle portion projects at its inferior part into an eminence called the *mental process*, or chin ; on each side of which is a depression for the muscles of the lower lip ; and externally to these depressions are two foramina, called *anterior mental*, for transmitting an artery and nerve of the same name.

The horizontal portions extend backward and outward, and on

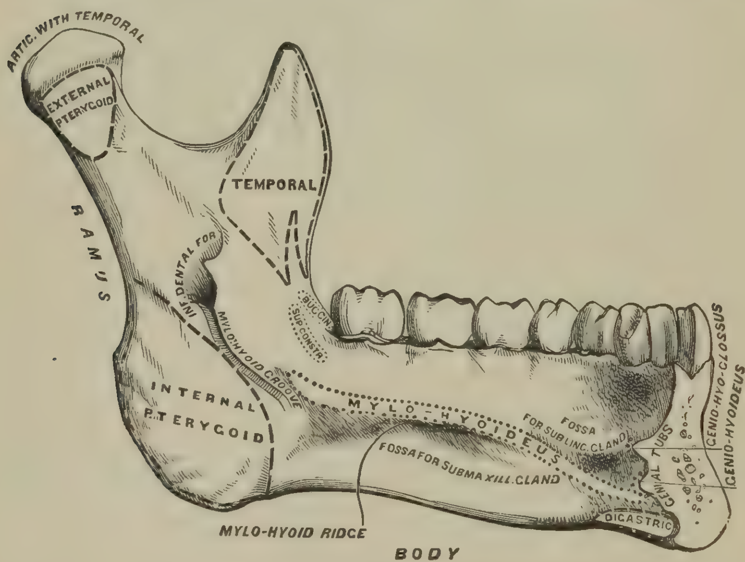

FIG. 10.

the outward surface have an oblique line for the attachment of muscles.

On the inner surface of the middle part, behind the chin, along the line of the symphysis, there is a chain of eminences called *genial tubercles*, to the superior of which the frenum linguæ is attached, to the middle the genio-hyo-glossi, and to the inferior the genio-hyoid muscles; on each side of these eminences are depressions for the sublingual glands; and beyond these depressions there runs an oblique ridge upward and outward, to the anterior part of which is attached the mylo-hyoid muscle, and to the posterior part, the superior constrictor of the pharynx; this latter muscle is consequently involved more or less in the extraction of the last molar tooth. Below this line

there is a groove for the mylo-hyoid nerve, and a depression, the submaxillary fossa, for the reception of the submaxillary gland.

The alveolar border, in the fetus, constitutes nearly the whole body of the bone. After the loss of the teeth, this part of the inferior maxillary is gradually wasted. The alveolar border in the lower jaw describes a rather smaller arch than it does in the upper, and both its anterior walls are thinner than the posterior. Passing over the inferior border, near the junction of the body with the ramus, is a groove for the facial artery.

The extremities of the body have two large processes rising up to an obtuse angle, named the *rami* of the lower jaw. These processes are flat and broad on their surfaces; the outer one is covered by the masseter muscle; the inner one has a deep groove which leads to a large hole, the *posterior dental* or maxillary foramen, for transmitting the inferior dental nerves and vessels to the dental canal running along the roots of the teeth. This foramen is protected by a spine to which the spheno-maxillary ligament is attached.

The ramus has a projection at its lower part, which is the angle of the lower jaw; its upper ridge is curved, having a process at each end—the anterior one is the *coronoid process;* this is triangular, and has the temporal muscle inserted into it; the posterior is the *condyloid*, and articulates with the temporal bone. This process has a neck which receives the insertion of the external pterygoid muscle.

The *Coronoid Process* is thin, flat, and triangular. To its external surface is attached the temporal and masseter muscles. On its internal surface is a long latitudinal ridge extending to the posterior part of the alveolar process, and to which is attached the temporal muscle above and the buccinator muscle below. In front of this ridge is a deep groove, to which the temporal and buccinator muscles are in part attached.

The *Condyloid Process* consists of two portions—a condyle and a neck. The condyle is of an oval form, convex both laterally and from before backward. The neck of the condyle, flattened from before backward, convex on its posterior surface, presents anteriorly a depression, the pterygoid fossa, for the attachment of the external pterygoid muscle. Between these two processes is the sigmoid notch, a semilunar depression over which passes the masseteric artery and nerve.

The structure of the inferior maxilla is compact externally, cellular within, and is traversed the greater part of its extent by the inferior dental canal.

The lower jaw is developed from two centers of ossification, which meet at the symphysis. It articulates on each side, by one of its con-

dyles, with the glenoid cavity of the temporal bone, situated at the base of the zygomatic process. This cavity is divided into two portions—an anterior and a posterior. The former constitutes the articular portion, the latter lodges a process of the parotid gland. The two are separated by the fissure of Glaserius, which transmits the chorda tympani nerve, the laxator tympani muscle, and the anterior tympanic artery. It also gives lodgment to the long process, *processus gracilis*, of the malleus.

Between this cavity and the condyle there is interposed an inter-articular cartilage, so molded as to fit the two articular surfaces. The circumference of this being free, except where it adheres to the external lateral ligament, affords attachment to a few fibres of the external pterygoid muscle, and facilitates the movements of the joint.

The union of this articulation is maintained by the external lateral, the spheno-maxillary, and the stylo-maxillary ligaments.

THE PALATE BONES.

The *Palate Bones*, two in number, are situated at the back part of the superior maxillary bone, between its tuberosities and the pterygoid process of the sphenoid bone.

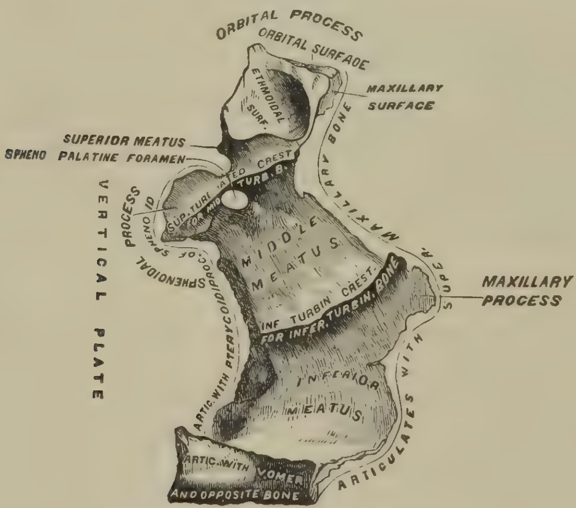

FIG. 11.

The palate bone is divided into two plates: the inferior, or horizontal, and the superior, or vertical.

The *horizontal plate* is broad and on the same line with the palate

processes of the superior maxillary bone; its upper surface is smooth and forms the posterior floor of the nostrils; the lower surface is rough and forms the posterior part of the roof of the mouth; its anterior edge is connected with the palate processes of the upper jaw, and its posterior is thin and crescentic, to which is attached the velum-pendulum palati, or soft palate; at the posterior point of the suture, uniting the two palate bones, there projects backward a process called the *posterior nasal spine*, which gives origin to the azygos-uvulæ muscle. The *vertical plate* ascends, helps to bound the nasal cavity, diminishes the opening into the antrum by projecting forward, and by its external posterior part, in conjunction with the pterygoid processes of the sphenoid bone, forms the *posterior palatine canal;* the lower orifice of which is seen on the margin of the palate plate, and is called the *posterior palatine foramen*, transmitting the palatine nerve and artery to the soft palate; behind this foramen is often seen a smaller one, passing through the base of the pterygoid process of this bone, and sending a filament of the same nerve to the palate.

The upper end of the vertical or nasal plate has two processes—the one is seen at the back of the orbit, called the *orbital* process; the other is posterior, and fits against the under surface of the body of the sphenoid bone. Between these two processes is a foramen, the *spheno-palatine*, which transmits to the nose a nerve and artery of the same name.

The palate bone articulates with six others, namely: the superior maxillary, inferior turbinated, vomer, sphenoid, ethmoid, and opposite palate.

The structure of this bone is very thin, and consists almost entirely of compact tissue. Its development, it is said, takes place by a single point of ossification at the union of the vertical, horizontal, and pyramidal portions.

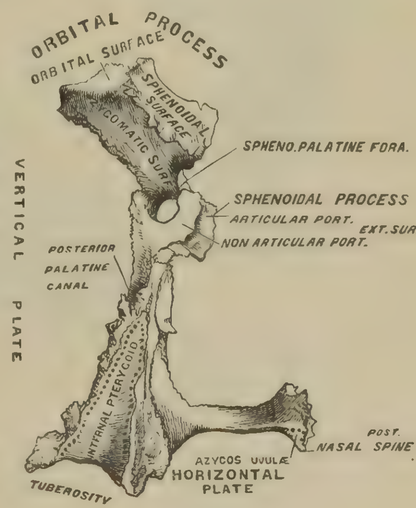

FIG. 12.

THE FRONTAL BONE.

The Frontal Bone consists of two portions—a vertical, or frontal, at the front part of the cranium, forming the forehead, and a horizontal,

or orbito-nasal, which enters into the formation of the roofs of the orbits of the eyes and nasal fossæ. The following points are found on the vertical portion :—

The *frontal eminences*, one on each side of the median line; the *superciliary ridges*, behind which are the *frontal sinuses;* the *supra-orbital notches*, or *foramina*, situated in the supraorbital arches about their inner third, for the supraorbital vessels and nerves; the *nasal eminence* at the lower end of the frontal depression; the *external angular processes*, which articulate with the malar bones and form the anterior part of the temporal ridges; the *internal angular processes*,

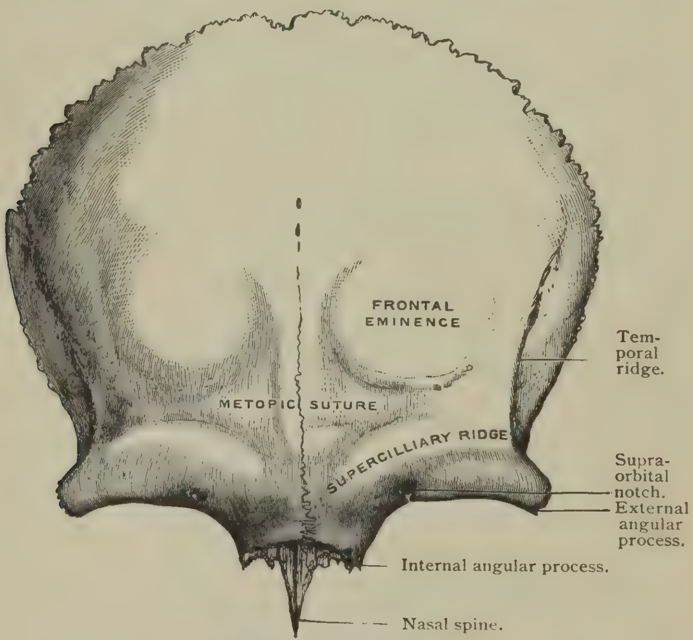

FIG. 13.—THE FRONTAL. (*Anterior view.*)

which articulate with the lachrymal bones; the *nasal spine and notch*, between the internal angular processes; and, internally, a *groove* for the superior longitudinal sinus and the falx cerebri; and the *frontal crest*, for the attachment of the falx cerebri; and the *foramen cæcum*, for a small vein to the longitudinal sinus; and depressions and elevations, for the convolutions of the brain. Between the two tables of the vertical portion are the *frontal sinuses*, which are lined with mucous membrane and open into the middle meatus of the nose by means of an infundibulum for each one.

The following points are found on its horizontal portion: a *fossa*

for the lachrymal gland, near the external angular process; a depression at the nasal margin, for the pulley of the superior oblique muscle; the *ethmoidal notch*, having on its margin the *anterior ethmoidal foramen;* the *posterior ethmoidal foramen*, the former for the anterior ethmoidal vessels and the nasal branch of the ophthalmic nerve, and the latter for the posterior ethmoidal vessels; also *grooves* on the cranial surface, for branches of the anterior and middle meningeal arteries.

The frontal bone articulates with twelve bones: the sphenoid, ethmoid, two parietal, two nasal, two superior maxillary, two lachrymal, and two malar. The following muscles are attached to it: temporal, corrugator supercillii, and orbicularis palpebrarum.

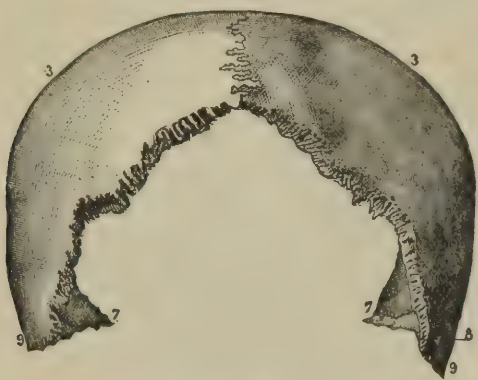

FIG. 14.
3, 3. Parietal bones. 7, 7. Spheno-parietal sutures. 9, 9. Temporo-parietal sutures.

THE PARIETAL BONES.

The two Parietal Bones are quadrilaterally shaped, so named from their forming the lateral walls of the skull, and situated at the superior and lateral regions of the cranium. They are joined at the superior borders by the *sagittal suture*, and the anterior border joins the frontal bone by a part of the *coronal suture;* the posterior border articulates with the occipital bone, forming the *lambdoidal suture;* the inferior border articulates with the sphenoid and temporal bones. Externally this bone is convex, and on this surface are found the following points: the *temporal ridge*, which is continuous with the same ridge on the frontal bone; the *parietal eminence*, the point where ossification commences; the *parietal foramen*, which is close to the upper border and transmits a vein to the superior longitudinal sinus. Internally this bone is concave, and on this surface the following points are found: *depressions*, for the Pacchionian bodies and for the cerebral convo-

lutions of the brain; *furrows*, for branches of the middle meningeal artery; a groove, for the lateral sinus, at the posterior inferior angle; a *half-groove* along the upper border, for the superior longitudinal sinus of the dura mater. Each parietal bone articulates with five bones, namely, the frontal, occipital, sphenoid, temporal, and the opposite parietal bone. The temporal muscle is the only one attached to the parietal bone.

THE OCCIPITAL BONE.

The Occipital Bone is trapezoidal in form, curved upon itself, and situated at the posterior and inferior region of the cranium. Its external surface is convex, and upon it are found the following points: The *external oblique protuberance and crest*, which affords attachment for the ligamentum nuchæ; the *superior and inferior curved* lines, which extend outward on each side of the external occipital crest; the *foramen magnum*, which transmits the medulla oblongata, the vertebral arteries, and the spinal accessory nerves; the *two condyles*, for articulation with the atlas vertebra; *two tubercles*, one on each condyle, for the check ligaments; the *two anterior condyloid foramina*, for the hypoglossal nerves; the *two posterior condyloid foramina*, when present, for veins; *two jugular processes*, which assist in forming the foramen lacerum posterius basis cranii. Its internal surface is concave, and presents the following points: *four fossæ*, for the cerebellar and posterior cerebral lobes; the *internal occipital protuberance*, where the six cranial sinuses meet to form the torcular Herophili; the *crucial ridge*, which is the vertical portion for the falx cerebri and falx cerebelli; a *groove*, for the lateral sinus and the inferior petrosal sinus; the *basilar process*, which lies in front of the foramen magnum and articulates with the body of the sphenoid bone, and grooved internally for the medulla oblongata and pons varolii, which lie upon it; inferiorly it is rough, for the attachment of the muscles, and presents the *pharyngeal spine* for the attachment of the superior constrictor muscle of the pharynx. The occipital bone articulates with six bones,—the two parietal, the two temporal, sphenoid, and

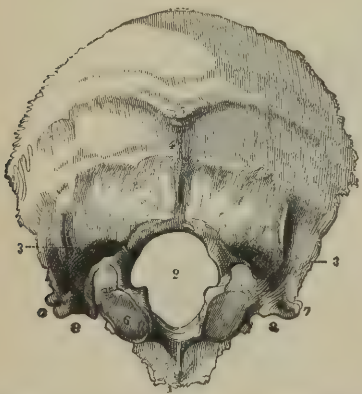

FIG. 15.—OCCIPITAL BONE. (*Postero-inferior view.*)

1. Basilar process. 2. Foramen magnum. 3, 3. Posterior condyloid foramina. 4. Crest. 5. External occipital protuberance. 6, 6. Condyles. 7, 7. Jugular processes. 8, 8. Jugular fossæ.

atlas. The muscles attached to the occipital bone are twelve in number,—the occipito-frontalis, trapezius, sterno-cleido-mastoid, complexus, splenius, obliquus capitis superior, rectus capitis posticus major and minor, superior constrictor of pharynx, rectus capitis anticus major and minor, and the rectus capitis lateralis.

THE TEMPORAL BONES.

The two Temporal Bones are situated at the inferior lateral portion of the skull, and contain the organs of hearing. Each bone is divided into three parts,—the *squamous* (scale-like), *mastoid* (nipple-like), and *petrous* (hard), and the bone is named from *tempus*—time.

"The squamous portion is semicircular, smooth externally, and grooved internally, for the middle meningeal artery, with depressions

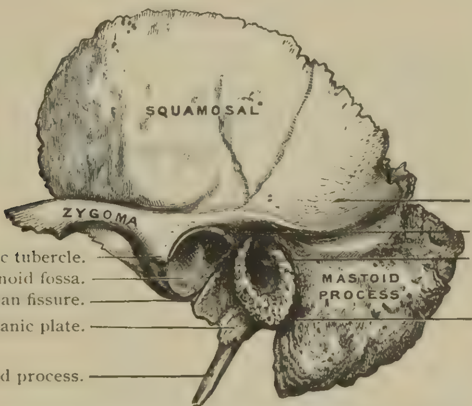

FIG. 16.—THE LEFT TEMPORAL BONE. (*Outer view.*)

for the cerebral convolutions. Externally the following points are found: the *zygomatic process*, or zygoma, extending forward to articulate with the malar bone; the *zygomatic tubercle* at the base of the process for the external lateral ligament of the lower jaw; the *eminentia articularis*, which is formed by the anterior root of the zygomatic process; the *glenoid fossa*, which is between the anterior and middle roots of the zygomatic process, its anterior part receiving the condyle of the lower jaw, and its posterior part lodging the parotid gland; the *Glaserian fissure*, which divides the glenoid fossa and transmits the laxator tympani muscle, the tympanic artery, and the processus gracilis of the malleus; the *opening of the canal of Hugier*, which lies in the angle between the squamous and petrous portions, and transmits the chorda tympani nerve; and a part of the *temporal ridge*. The mastoid portion presents the following points:

it projects like a nipple from the inferior part of the bone posteriorly, and internally it is grooved for the lateral sinus. Externally are found the *mastoid foramen* for a vein ; the *mastoid process* at the tip, for sterno-cleido-mastoid, splenius, and trachelo-mastoid muscles ; the *digastric fossa*, for the posterior belly of the digastric muscle ; the *occipital groove*, for the occipital artery ; and the mastoid cells, which open on the posterior wall of the middle ear and are lined with mucous membrane.

The petrous portion is hard, pyramidal in form, and contains the internal and middle ear, projecting inward and forward, and having a base, an apex, three surfaces, and three borders. On the base are found the *meatus auditorius externus*—the external opening of the ear ; and the *auditory* process, which is an osseous ring for the external cartilage of the ear. The Apex is situated internally at the base of the skull, and forms the outer boundary of the foramen lacerum medium, and contains the internal carotid canal. The Anterior Surface, from within outwards, presents the *opening of the carotid canal*, for the internal carotid artery and plexus. The *depression* contains the Gasserion ganglion of the fifth pair of nerves. The *hiatus fallopii* is for the great petrosal nerve and an artery ; and the *foramen* is for the small petrosal nerve.

The Posterior Surface presents the *meatus auditorius internus*, for the transmission of the seventh and eighth pairs of cranial nerves and the auditory artery, and also lodges a process of the dura mater. The Inferior Surface presents the *opening of the carotid canal* for transmitting the internal carotid artery, and the carotid plexus of the sympathetic nerve ; the *rough quadrilateral surface*, for the origin of the tensor tympani and levator palati muscles ; the *aqueductus* cochlea, for transmitting a vein from the cochlea ; the *jugular fossa*, a depression for the sinus of the internal jugular vein, forming with the occipital bone the foramen lacerum posterius, which transmits that vein and the eighth pair of nerves ; a *foramen* for Jacobson's nerve and another foramen for Arnold's nerve ; the *jugular surface*, for articulation with the jugular process of the occipital bone ; the vaginal process ensheathing the root of the styloid process ; the *styloid process*, for the stylo-pharyngeus, stylo-hyoid, and the stylo-glossus muscles ; the *stylo-mastoid* foramen, for the exit of the facial nerve, and the entrance of the stylo-mastoid artery ; the *septum tubæ lamina*, which separates the tympanum and is called *processus cochleariformis ; opening* of the canal for the tensor tympani muscle ; the *osseous opening* of the Eustachian tube. The temporal bone articulates with five bones,—the occipital, parietal, sphenoid, malar, and inferior maxillary. Fourteen muscles are attached to the different parts of this bone : the tem-

poral, masseter, occipito-frontalis, sterno-cleido-mastoid, splenius capitis, trachelo-mastoid, digastric, retrahens aurem, tensor tympani, levator palati, stapedius, stylo-glossus, stylo-hyoid, and stylo-pharyngeus.

THE SPHENOID BONE.

The sphenoid bone resembles a bat with outstretched wings, and is named from the Greek word σφεν, a wedge. Wedged in between the bones of the skull anteriorly, this bone enters into the formation of five cavities, four fossæ, three fissures, and consists of *a body*, *two greater wings*, *two lesser wings*, *two pterygoid processes*, *two styloid processes*, *six clinoid processes*, *three lesser processes*, *twelve foramina*, has twelve articulations with other bones of the head and face, and to it

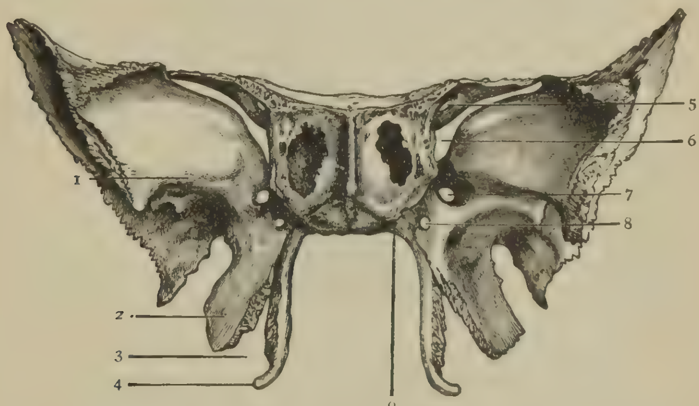

FIG. 17.—THE SPHENOID. (*Anterior view.*)
1. Orbital surface. (The pointer crosses the malar crest.) 2. Ext. pterygoid plate. 3. Pterygoid notch. 4. Hamular process. 5. Optic foramen. 6. Sphenoidal fissure. 7. Foramen rotundum. 8. Vidian canal. 9. Pterygo-palatine canal.

are connected twelve pairs of muscles ; it has also ten points of ossification. The body of the sphenoid bone is cuboid in shape, and located in the median line. Its Upper Surface from before backward, presents the following points : A *smooth surface*, grooved for the olfactory nerves ; *ethmoidal spine* ; *optic groove*, for the support of the commissure of the optic nerve ; *olivary process*, in the form of an olive-shaped eminence behind the optic groove ; *middle clinoid processes*, bounding the sella turcica in front ; *sella turcica*, which lodges the pituitary body and circular sinus of the brain (so called from its resemblance to a Turkish saddle) ; *dorsum sellæ* (or back of saddle), which is grooved for the sixth pair of nerves ; *posterior clinoid processes*, for attachment of the tentorium cerebelli ; *lateral grooves*, for the cavernous sinus and internal carotid artery.

The Anterior Surface is almost vertical, and presents the following points: *lamella* in the median line, articulating with the perpendicular plate of the ethmoid bone, and forming part of the nasal septum; *opening of the sphenoidal sinuses* or cavities in the body of the bone—common to adults only; *sphenoidal turbinated bones* (the pyramids of Wistar), which partially close the sinuses, and articulate with the ethmoid and palate bones.

The Inferior Surface assists in forming the nasal fossæ, and presents the following points: *rostrum*, which articulates with a groove on the vomer; *vaginal processes*, one on each side of the rostrum; *pterygo-palatine grooves*, which in connection with the sphenoidal processes of the palate bones form the pterygo-palatine canals for the transmission of the pterygo-palatine arteries and nerves. Each of the greater wings of the sphenoid bone on its superior surface presents the following points: *foramen rotundum*, for the superior maxillary division of the fifth pair of nerves; *foramen ovale*, for the inferior maxillary division of the fifth pair of nerves, the small petrosal nerve, and the small meningeal artery; the *foramen vesalii*, for transmitting a small vein; *foramen spinosum*, for transmitting the middle meningeal artery.

The Anterior Surface assists in forming the external wall of the orbit of the eye, the spheno-maxillary and sphenoidal fissures. It articulates with the frontal and malar bones, and contains a *notch*, for a branch of the ophthalmic artery; a *spine*, for part of the lower head of the external rectus muscle; the *external orbital foramina*, for arterial branches.

The *external surface* presents the following points: *pterygoid ridge*, which divides the temporal fossa from the zygomatic; the *spine of the sphenoid*, to which the internal lateral ligament of the lower jaw and the laxator tympani muscles are attached. The circumference is partly serrated for articulation with the temporal bone, and partly smooth for the anterior margin of the foramen lacerum medium and the inferior margin of the sphenoidal fissure, which margin it assists in forming.

The lesser wings of the sphenoid bone (Processes of Ingrassias) terminate internally in the anterior clinoid processes. Their anterior borders articulate with the orbital plate of the frontal bone, while the posterior are free, dividing the anterior cerebral fossa from the middle. Intimately connected with each of these wings are the *optic foramen*, for the transmission of the optic nerve and the ophthalmic artery; also the *sphenoidal fissure*, or foramen lacerum anterius, which transmit the third, fourth, the ophthalmic division of the fifth and sixth pairs of nerves, the ophthalmic vein, branches of the lachrymal and middle meningeal arteries, some filaments of the sympathetic nerve, and a process of the dura mater. The wing-like processes (*pterygoid pro-*

cesses) descend, one on each side of the body of the bone, and each divide into two thin bony plates connected together in front, and presenting the pterygoid fossa, the origin of the external pterygoid muscle ; the *scaphoid fossa*, which serves as the origin of the tensor palati muscle ; the *vidian canal* at the root of the process for the vidian nerve and vessel ; the *triangular notch* at the end of the process, which articulates with the pterygoid process of the palate bone.

The sphenoid bone articulates twelve other bones of the cranium and face, such as the remaining seven of the cranium and the five of the face, viz.: the vomer, two malar, and two palate bones. The muscles attached to the sphenoid bone are twelve pairs, viz.: the six orbital muscles, the temporal, external and internal pterygoids, superior constrictor, tensor palati, and laxator tympani.

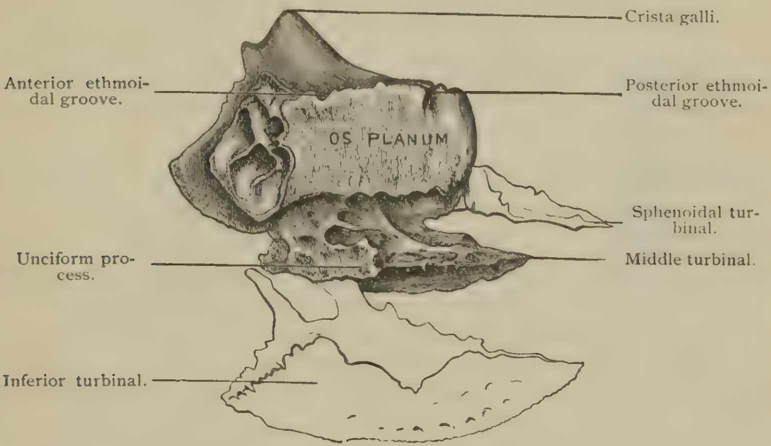

FIG. 18.—THE ETHMOID. (*Side view.*)

THE ETHMOID BONE.

The Ethmoid Bone is light and spongy, depending from the ethmoidal notch of the frontal bone, and from between its orbital plates. It consists of a body and two lateral masses, and is named from the Greek word ηθμος, a sieve. The body of this bone consists of a horizontal cribriform plate, and a perpendicular plate, and presents the following points : the *crista galli*, or cock's comb, projecting upwards for the attachment of the anterior end of the falx cerebri ; the *cribriform plate* on each side of the crista galli, which is concave for the olfactory bulbs, and perforated for the transmission of the olfactory nerves, the nasal branch of the ophthalmic nerve, and numerous small vessels ; the *perpendicular plate*, which assists to form the septum of the nose, usually inclined to one side, and grooved for filaments of the olfactory

4

nerves, and having attached to it the cartilage of the nose. The *lateral masses* consist of a number of cellular cavities and each mass presents the following points: *ethmoid cells*, the anterior opening by the infundibulum into the middle meatus of the nose, the posterior opening into the superior meatus of the nose; the *os planum*, or orbital plate, which helps to form the inner wall of the orbit of the eye, and which is notched superiorly to form with the frontal bone the two ethmoidal foramina; the *unciform process*, which descends to articulate with the inferior turbinated bone, and forms part of the inner wall of the antrum; the *superior turbinated process*, which curves downward and outward; the *middle turbinated process*, which is larger and more curved than the superior. These processes bound the superior meatus of the nose and are frequently called the *superior* and *middle turbinated bones*. The ethmoid bone articulates with fifteen bones—all those of the face, except the malar, and the frontal and sphenoid of the cranium. There are no muscles attached to it.

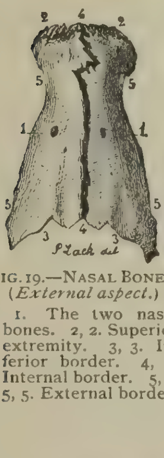

FIG. 19.—NASAL BONES. (*External aspect.*)
1, 1. The two nasal bones. 2, 2. Superior extremity. 3, 3. Inferior border. 4, 4. Internal border. 5, 5, 5, 5. External border.

THE NASAL BONES.

The Nasal Bones are two in number, and together they form the bridge of the nose by articulation with each other in the median line. They are convex externally, and concave internally, and are grooved for the external branch of the nasal nerve and for small arteries. Each of the nasal bones articulates with four bones—the frontal, ethmoid, superior maxillary, and the opposite nasal bone. They have no muscles attached to them.

THE MALAR BONES.

The Malar or Cheek Bones are situated at the outer and upper part of the face, and assist in forming the cavities of the orbits of the eyes, and the temporal and zygomatic fossæ. Each malar bone presents the following points: An *external surface*, which is convex, for the attachment of the zygomatic muscles; a *foramen*, externally, for the malar branch of the temporo-malar nerve; a *foramen*, internally, for the temporal branch of the temporo-malar nerve; a *frontal process* which articulates with the external angular process of the frontal bone; an *orbital process* projecting backwards, and forming part of the floor and outer wall of the orbit of the eye, and also a part of the temporal fossa; a *zygomatic process*, which projects backwards to articulate with the zygomatic process of the temporal bone by a serrated edge; an *upper border*, which forms the outer and inferior

margin of the orbit of the eye; a *lower border*, which is thick and rough for the origin of the masseter muscle; an *anterior border*, which articulates with the superior maxillary bone; a *posterior border*, which terminates the temporal fossa below.

Each Malar Bone articulates with four bones: the frontal, sphenoid, temporal, and superior maxillary. Five muscles are attached to it: the levator labii superioris, zygomaticus major and minor, masseter and temporal.

FIG. 20.—MALAR BONE. (*External aspect.*)

1. Orifice for malar nerve. 2, 2. Superior or orbital border. 3, 3. Inferior or zygomatic border. 4, 4. Posterior or temporal border. 5, 5. Anterior or maxillary border. 6. Superior angle. 7. Inferior angle. 8. Anterior angle. 9. Posterior angle.

THE LACHRYMAL BONES.

The Lachrymal Bones consist of two small quadrilateral bones, situated in the anterior part of the inner wall of the orbit of the eye. Each lachrymal bone presents the following points: a *groove* on the external surface, which forms a part of the nasal duct; a *ridge*, externally, for attachment of the tensor tarsi muscle; a *furrow*, internally, corresponding to the ridge on the external surface; the *hamular process*, which projects downwards to articulate with the lachrymal process of the inferior turbinated bone; an *internal surface*, which closes the anterior ethmoidal cells. Each lachrymal bone articulates with four bones: the frontal, ethmoid, superior maxillary, and inferior turbinated. There is but one muscle attached to it—the tensor tarsi.

FIG. 21.—LACHRYMAL BONE. (*External aspect.*)

1, 1. Vertical crest, dividing external surface into two parts. 2. Spine, in which crest terminates. 3. Sulcus contributing to formation of lachrymal canal. 4. Continuation of preceding, contributing to formation of nasal canal. 5. Posterior division of external surface, contributing to formation of orbit. 6, 6. Anterior border. 7, 7. Posterior border. 8. Superior extremity. 9. Portion of inferior border that articulates with lachrymal process of inferior turbinated bone. 10. Portion that articulates with orbital plate of superior maxillary bone.

THE INFERIOR TURBINATED BONES.

The Inferior Turbinated Bones are two in number, situated in the nasal fossæ, their convex surfaces presenting inwardly. They are in the form of two thin, curved osseous plates, and each is attached above to the inferior turbinated crests of the superior maxillary and palate bones, and presents the following: The *lachrymal process*, which

assists in forming the nasal duct, by articulation with the lachrymal and superior maxillary bones; the *ethmoidal process*, which articulates with the unciform process of the ethmoid bone, thus assisting to partially close the aperture of the antrum; the *maxillary process*, which also assists in partially closing the aperture of the antrum by bending over the lower edge of that orifice; the *free border*, below, which reaches to about one-half an inch above the floor of the nose. Each inferior turbinated bone articulates with four bones, the ethmoid, lachrymal, palate, and superior maxillary, and has no muscles attached to it.

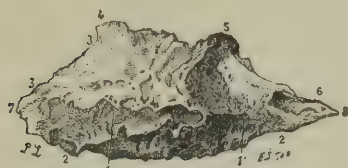

FIG 22.—INFERIOR TURBINATED BONE. (*Internal or Convex aspect.*)

1, 1. Antero-posterior ridge, dividing the internal surface into two almost equal parts. 2, 2. Inferior border. 3, 3. Anterior portion of superior border, articulating with nasal process of superior maxillary bone. 4. Lachrymal process. 5. Ethmoidal process. 6. Portion of superior border that articulates with palate bone. 7. Anterior extremity. 8. Posterior extremity.

THE VOMER.

The Vomer, so called from its shape resembling that of a plowshare, forms the posterior part of the nasal septum, but is usually bent to one side. It presents: A *superior border*, with a groove and two wings (alæ), for articulation with the rostrum and vaginal processes of the sphenoid bone; an *anterior border*, which is grooved for the ethmoidal plate and the nasal cartilage; an *inferior border*, which is the longest, and articulates with the nasal crest of the superior maxillary and palate bones; a *posterior border*, which is free and presents toward the pharynx; *naso-palatine grooves*, laterally, for the naso-palatine nerves; *furrows*, on the lateral surface, for nerve filaments and blood-vessels. The vomer articulates with six bones,—sphenoid, ethmoid, two superior maxillary, and two palate bones. It has no muscles attached to it.

FIG. 23.—THE VOMER. (*Side view.*)

CHAPTER IV.

MUSCLES.

Muscles are the fleshy parts of the body. They are the active organs of locomotion, and are composed of fibres bound together in bundles, or fasciculi, by delicate areolar tissue.

The muscular fibres of which each muscle is compounded are called ultimate fibres. Of these anatomists recognize two kinds—voluntary or animal fibres (striped), and involuntary or organic fibres (unstriped). The former are generally under the influence of the will, are of uniform size, and present transverse markings. They compose the muscles of the trunk and limbs, as well as those of the heart, urethra, internal ear, and, in part, those of the œsophagus; though the muscles of the heart are striped, they are not voluntary; the muscular coat of the urethra consists of two layers of plain, muscular fibre; the muscles of the internal ear are striped, but are not voluntary; in the upper part of the œsophagus the muscular fibres consist chiefly of the striped variety, but below they consist entirely of the involuntary or unstriped muscular fibre.

The involuntary fibres are not under volitional control, are not striped, are of smaller size and homogeneous structure. They are found in the digestive canal, uterus, and bladder. The voluntary muscles terminate in fibrous tissue, which is sometimes gathered together in bundles to form tendon, or is spread out in a membranous form, and is then called aponeurosis. By one or the other of these terminal forms almost all muscles are attached to those parts which it is their office to move.

The involuntary muscles are generally found interlacing freely around a cavity, which, by their contraction, they constrict, expelling its contents. Each muscle is closely though loosely invested by a sheath of cellular tissue, which also sends prolongations into the body of the muscle, investing each fibre and binding them together. The muscles of expression, which are especially interesting in their relation to prosthetic dentistry, are quite numerous, and are very closely connected with the subcutaneous tissue and the skin. Muscles are variously named, according to their form, long, broad, short, etc. These names sufficiently explain themselves. Other names are given them, depending on the arrangement of their fibres, their situation, number of divisions, office, etc. The muscles of the mouth, for example, are named elevators, depressors, sphincters, etc., according to their respective functions. For fuller explanation, students are referred to more exclusively anatomical works.

The *Fascia*, which everywhere invests the more delicate organs, is of two kinds—superficial, or fibro-areolar, and deep, or aponeurotic. The superficial fascia lies just beneath the skin, and covers nearly the entire surface of the body. It serves to connect the skin with the deep fascia, and furnishes a nidus for nerves and blood-vessels passing to the skin.

The deep fascia is composed of fibres arranged in a reticulated manner, forming a dense, inelastic membrane, which invests each muscle in a separate sheath. Sheaths are also formed from it for the vessels and nerves; and it serves also as points of attachment for the muscles.

Each striped muscular fibre is composed of two parts—a proper substance called the sarcous element, in which the contractile property resides, and a sheath or sarcolemma, a transparent, structureless membrane, in which is contained the contractile substance. These elementary fibres are connected by areolar tissue, with which a little fat is often associated. Lying between these fibres are blood-vessels, nerves, and lymphatics.

The sarcous element is a soft, granular material, on the varying relations of which granules to each other depend the alterations in appearance of the striæ. If they approach each other more closely in the direction of the length of the fibre than in its width, it will appear fibrillated; if the reverse, it will present the appearance of discs.

Muscles, like all other tissues, are developed from germinal matter which has undergone special metamorphosis, under the impulse of the parent cell, to construct this tissue. "Germinal matter" and "formed material" constitute the "elementary part," according to Mr. Beale, or the muscular cell, of the other writers, from which the muscular fibre is formed. In the formed material, which is the constructed muscle, resides the power of contraction. The germinal matter, or constructive part, does not possess this property.

Following the arrangement of Mr. Gray, we shall divide the muscles which it is our purpose to describe into certain groups, as follows:—

1. NASAL GROUP.
Pyramidalis Nasi.
Levator Labii Superioris Alæque Nasi.
Levator Proprius Alæ Nasi Posterior.
Levator Proprius Alæ Nasi Anterior.
Compressor Naris.
Compressor Narium Minor.
Depressor Alæ Nasi.

2. SUPERIOR MAXILLARY GROUP.
Levator Labii Superioris Proprius.
Levator Anguli Oris.
Zygomaticus Major.
Zygomaticus Minor.

3. INFERIOR MAXILLARY GROUP.
Levator Labii Inferioris.
Depressor Labii Inferioris.
Depressor Anguli Oris.
Platysma Myoides.

Adjunct Group.

Musculus Risorius.
Orbicularis Oris.
Buccinator.

4. Temporo-Maxillary Group.

Masseter.
Temporal.

5. Pterygo-Maxillary Group.

Pterygoideus Externus.
Pterygoideus Internus.

6. Lingual Group.

Genio-hyo-glossus.
Hyo-glossus.
Lingualis.
Stylo-glossus.
Palato-glossus.

7. Pharyngeal Group.

Constrictor Inferior.
Constrictor Medius.
Constrictor Superior.
Stylo-pharyngeus.
Palato-pharyngeus.

8. Palatal Group.

Levator Palati.
Tensor Palati.
Azygos Uvulæ.
Palato-glossus.
Palato-pharyngeus.

1. Nasal Group.

Pyramidalis Nasi.
Levator Labii Superioris Alæque Nasi.
Levator Proprius Alæ Nasi Posterior.
Levator Proprius Alæ Nasi Anterior.
Compressor Naris.
Compressor Narium Minor.
Depressor Alæ Nasi.

The *Pyramidalis Nasi* is a triangular, muscular slip extended from the occipito-frontalis. It lies along the side of the nose, and blends by a tendinous expansion with the compressor naris.

The *Levator Labii Superioris Alæque Nasi* is also a triangular muscle, arising from the nasal process of the superior maxilla, its upper part. Passing down behind the muscle just described, it divides into two muscular slips, one of which is inserted into the cartilage of the ala of the nose, the other is continued to the angle of the mouth, where it blends with the orbicularis oris and levator labii proprius.

Beneath this muscle is a small muscular slip extending from the origin of the compressor naris to the nasal process, about an inch above it. It is called the "Musculus Anomalus," or the "Rhomboideus."

The *Levator Proprius Alæ Nasi Posterior*, or Dilator Naris Posterior, extends from the nasal notch to the margin of the nostril.

The *Levator Proprius Alæ Nasi Anterior*, or the Dilator Naris Anterior, is situated a little in front of the last described muscle, and

arises from the cartilage of the wing of the nose, and is inserted into the integument near its margin.

The *Compressor Naris*, triangular in form, arises from the superior maxilla, a little above and external to the incisive fossa, and is attached to the fibro-cartilage of the nose, joining at the median line with its fellow of the opposite side.

The *Compressor Narium Minor* extends from the alar cartilage to the integument of the end of the nose.

The *Depressor Alæ Nasi* arises from the incisive fossa of the superior maxilla, and, dividing into two sets of fibres, ascending and descending, is inserted into the septum and posterior portion of nasal cartilage, and by some fibres of the latter into the back part of the orbicularis oris.

The facial nerve supplies all the muscles of this group.

Their respective actions are sufficiently explained by their names, except the pyramidalis, which draws down the inner angle of the eyebrow, and perhaps aids in dilating the nostril, and the compressores nasi, whose action is directly opposite to that implied by their names.

The contraction of the levator labii superioris alæque nasi gives to the face the expression of contempt.

2. Superior Maxillary Group.

Levator Labii Superioris Proprius.
Levator Anguli Oris.
Zygomaticus Major.
Zygomaticus Minor.

The *Levator Labii Superioris Proprius*, arises from the lower margin of the orbit, some of its fibres from the superior maxillary, others from the malar bone; they pass down to be inserted in the fleshy part of the upper lip.

The *Levator Anguli Oris* arises from the canine fossa, just below the infra-orbital foramen, and descends to the angle of the mouth, where it blends with the orbicularis oris, the zygomatici, and the depressor anguli oris muscles.

The *Zygomaticus Major* is a delicate fasciculus, arising from the malar bone, and finding attachment to the orbicularis and depressor anguli oris at the angle of the mouth.

The *Zygomaticus Minor* arises from the malar bone, just behind the maxillary suture, and passes downward and inward, to be inserted in the outer margin of the levator labii superioris, with which it is continuous.

These muscles are also supplied by the facial nerve.

The action of the levator muscles is described in their names. The zygomatici draw the lip upward and outward, as in laughing.

3. Inferior Maxillary Group.

Levator Labii Inferioris.	(Levator Menti.)
Depressor Labii Inferioris.	(Quadratus Menti.)
Depressor Anguli Oris.	(Triangularis Menti.)
Platysma Myoides.	

The *Levator Labii Inferioris* arises from the incisive fossa just external to the symphysis of the chin; it is a small, conoidal fasciculus, and is inserted into the integument of the chin.

The *Depressor Labii Inferioris* is a quadrilateral muscle, arising from the oblique line of the inferior maxilla, between the incisive fossa and mental foramen, and is attached to the integument of the lower lip, blending with the orbicularis and with its fellow of the opposite side.

The *Depressor Anguli Oris*, situated externally to the last-mentioned muscle, also arises from the external oblique line of the lower jaw, and is attached at the angle of the mouth to the orbicularis, levator anguli, and zygomaticus major muscles.

The facial nerve supplies this group.

Their action is indicated by their names.

The *Platysma Myoides* arises from the subcutaneous tissue over the pectoralis major, trapezius, and deltoid muscles, and passes obliquely over the clavicle and the side of the neck, its fibres terminating in the skin of the chin, the subcutaneous tissue of the cheek, the muscles at the corner of the mouth, the middle fibres being attached along the base of the jaw. It forms a defense for the neck, and is a muscle of expression from its functions of moving the skin, belonging to the class known as cutaneous muscles.

The Musculus Risorius, Orbicularis Oris, and Buccinator form a group closely connected with the superior and inferior maxillary groups.

The *Musculus Risorius* is considered by many as a part of the platysma myoides, the large subcutaneous muscle of the neck. It arises from the fascia over the masseter muscle, and, after passing horizontally forward, is inserted into the angle of the mouth, where it joins the orbicularis oris and depressor anguli oris. It gives the smile of derision.

The *Orbicularis Oris* surrounds the mouth, and forms a center from which muscles diverge and are fixed into the surrounding bones. It is the antagonist of all the muscles which move the lips, and has no bony origin or insertion. It is nearly an inch in breadth, and the prominence of the lips depends upon its size and thickness.

The *Buccinator* arises from the outer surface of the alveolar borders

of the superior and inferior maxillæ, corresponding to the molar teeth, and its fibres pass forward and are inserted into the angle of the mouth and the muscular structure of the lips. The buccinator is the principal muscle of the cheek, and, with the superior constrictor of the pharynx, forms a muscular wall for the sides of the mouth and pharynx. It is pierced by the duct of the parotid gland, which opens into the mouth opposite the superior second molar tooth. The functions of the buccinator are to expel air from the mouth by inflating the cheek, to widen the mouth, and to keep the food between the teeth during mastication. The facial nerve supplies this muscle, which is affected in facial paralysis. The buccinator muscle is covered by a thin layer of fascia known as the buccal fascia, which adheres closely to its surface and is attached to the alveolar border of the superior and inferior maxillæ. The density of this fascia prevents abscesses from readily discharging into the mouth or the pharynx.

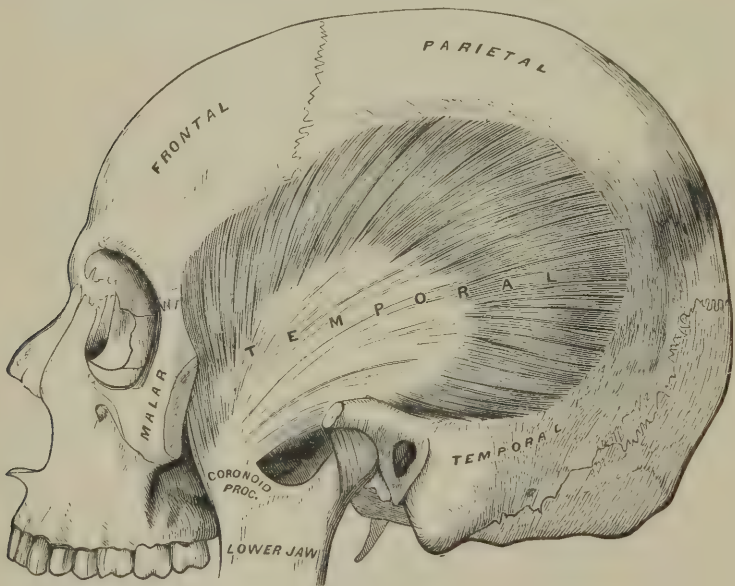

FIG. 24.

4. Temporo-Maxillary Group.

Temporal.
Masseter.

The *Temporal Muscle* (Fig. 24) is seen on the side of the head. It has its origin from the semicircular ridge, commencing at the external angular process of the os-frontis, and extending along this and the parietal bone; also from the surface below this ridge formed by the

frontal and squamous portion of the temporal and sphenoid bones; likewise from the under surface of the temporal aponeurosis, and from a fascia covering this muscle; and its fibres are inserted, after they have converged and passed under the zygoma, into the coronoid process of the lower jaw, surrounding it on every side by a dense, strong tendon.

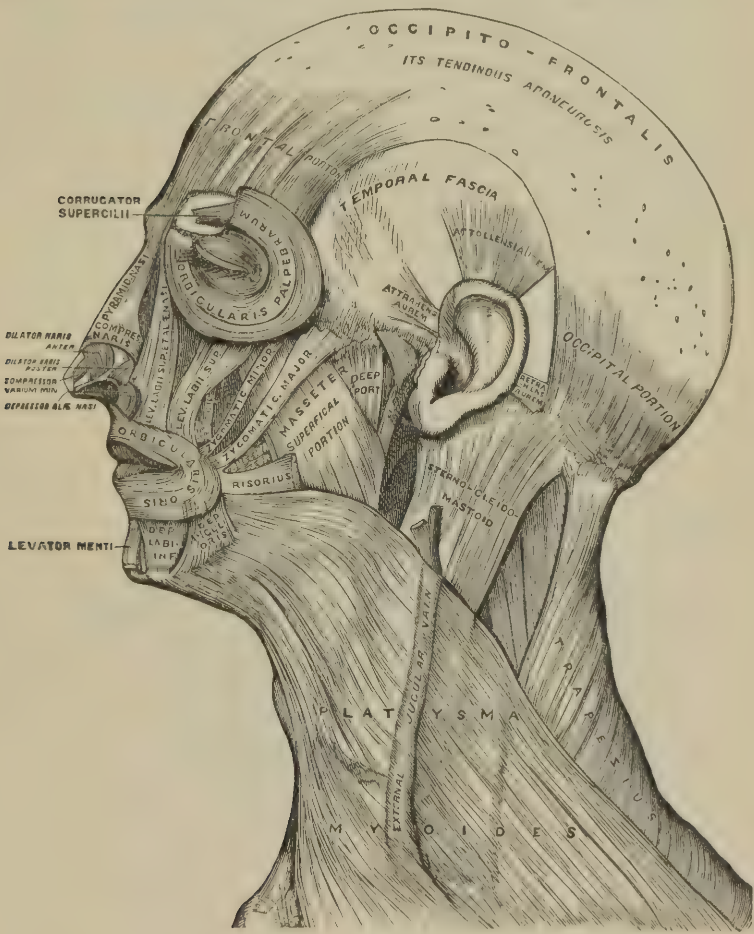

FIG. 25.

The *Masseter Muscle* (Fig. 25) is seen at the side and back part of the face, in front of the meatus externus, and lies directly under the skin. It arises by two portions: the one, anterior and tendinous, from the superior maxilla where it joins the malar bone; the other portion, mostly fleshy, from the inferior edge of the malar bone and the zygomatic arch as far back as the glenoid cavity, and is inserted,

tendinous and fleshy, into the external side of the ramus of the jaw and its angle as far up as the coronoid process.

The inferior maxillary nerve supplies both these muscles.

The office of the temporal muscle is to bring the two jaws together, as in the cutting and rending of the food.

The use of the masseter muscle, when both portions act together, is to close the jaw; if the anterior acts alone, the jaw is brought forward; if the posterior, it is drawn backward.

The use of the pterygoid muscle is to aid the temporal and masseter muscles in the trituration of the food. The external pterygoids carry the lower jaw directly forward when acting together; to one or the other side when acting separately. The internal pterygoid aids the masseter and temporal in bringing the lower jaw firmly up against the superior maxilla, and also assists in carrying the lower jaw forward.

The inferior maxillary nerve supplies these muscles, which form the pterygo-maxillary group, and which come next in order of description.

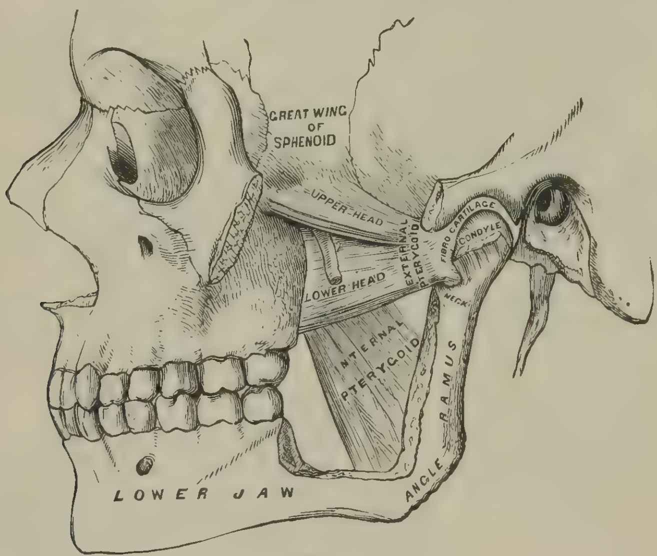

FIG. 26.

5. PTERYGO-MAXILLARY GROUP.

Pterygoideus Externus.
Pterygoideus Internus.

Pterygoideus Externus (Fig. 26) arises from the outer surface of the external plate of the pterygoid process of the sphenoid bone, from the tuberosity of the superior maxilla, and from the ridge on the sphenoid bone separating the zygomatic from the pterygoid fossa, and is in-

serted into the inner side of the neck of the lower jaw, and capsular ligament of the articulation.

Pterygoideus Internus arises, tendinous and fleshy, from the inner surface of the pterygoid plate, fills the greater part of the pterygoid fossa, and is inserted, tendinous and fleshy, into the inner face of the angle of the inferior maxilla and the rough surface above the angle.

The external one is triangular, having its base at the pterygoid process and running outward and backward to the neck of the condyle. The internal is strong and thick, placed on the inside of the ramus of the jaw, and running downward and backward to the angle.

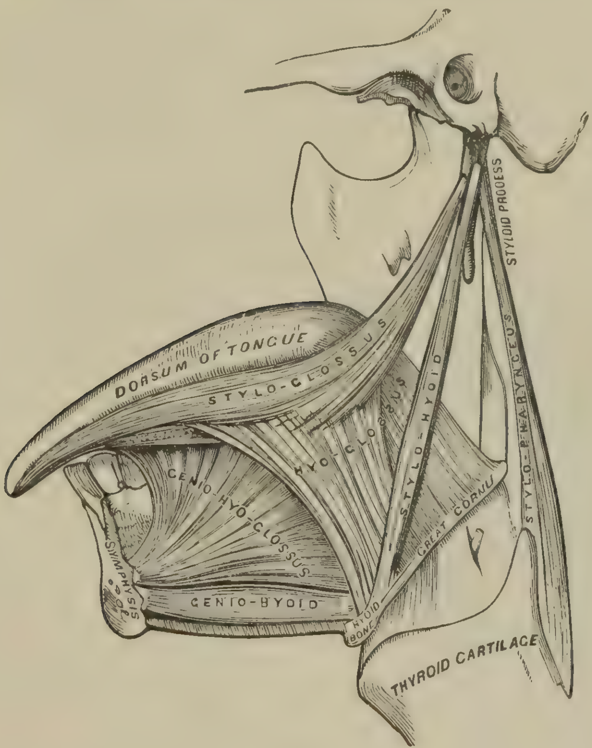

FIG. 27.

6. Lingual Group.

Genio-hyo-glossus. Lingualis.
Hyo-glossus. Stylo-glossus.
Palato-glossus.

The *Genio-hyo glossus* (Fig. 27) is attached, as its name implies, to the chin, hyoid bone, and tongue. It is a triangular, fan-like muscle, arising by its apex from the superior genial tubercle, and has its

inferior fibres running parallel with the genio-hyoid to be inserted into the hyoid bone, while its middle and anterior fibres are inserted into the under surface of the tongue its whole length.

The *Hyo-glossus*, a thin, broad, quadrilateral muscle, has its *origin* from the body, cornu, and appendix of the os-hyoides, and is *inserted* into the side of the tongue, forming the greater part of its bulk.

The *Lingualis* has its origin on the under surface of the tongue, extending from its base and hyoid bone to the apex, and so intermingling with the other muscles as to be considered rather a part of them than a distinct muscle.

The *Stylo-glossus* arises from the point of the styloid process and stylo-maxillary ligament. It is inserted into the side of the tongue near its root, its fibres running to the tip.

The *Palato-glossus* is more directly associated with the soft palate, and will consequently be described with the palatal group.

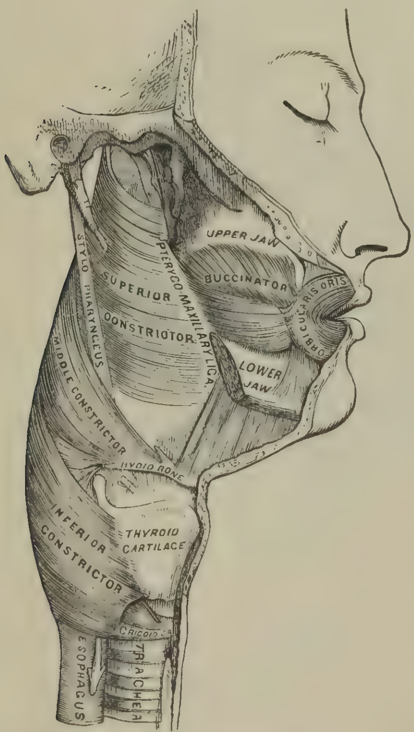

FIG. 28.

7. Pharyngeal Group.

Constrictor Inferior.
Constrictor Medius.
Constrictor Superior.
Stylo-pharyngeus.
Palato-pharyngeus.

The *Inferior Constrictor* of the pharynx (Fig. 28) arises from the side of the thyroid cartilage and its inferior cornu, and from the side of the cricoid cartilage, and is inserted with its fellow into the middle line on the back of the pharynx. This is the largest of the constrictor muscles, and overlaps the middle constrictor.

The *Middle Constrictor* of the pharynx (Fig. 28) arises from the appendix and both cornua of the os-hyoides, and from the thyro-hyoid ligament; its fibres ascend, run transversely, and descend, giving a triangular appearance; the upper ones overlap the superior constrictor,

while the lower are beneath the inferior; the whole pass back to be inserted into the middle tendinous line of the pharynx.

The *Superior Constrictor* (Fig. 28) arises from the cuneiform process of the occipital bone, from the lower part of the internal pterygoid plate of the sphenoid bone, from the pterygo-maxillary ligament, and from the posterior third of the mylo-hyoid ridge of the lower jaw, near the root of the last molar tooth. It is inserted with its fellow into the middle tendinous line at the back of the pharynx.

The *Stylo-pharyngeus* arises from the root of the styloid process, and is inserted into the side of the pharynx and corner of the os hyoides and thyroid cartilage. It is a long and narrow muscle, and passes to the pharynx between the upper and middle constrictors.

The *Palato-pharyngeus*, which forms the posterior pillar of the soft palate, is a long, fleshy muscle, wider at either extremity than in the middle, and arises from the soft palate by a divided fasciculus, between which points of attachment lies the levator-palati. It passes behind the tonsil, downward and outward, to be inserted into the posterior part of the thyroid cartilage, together with the stylo-pharyngeus.

The muscles of this group are supplied with nerves from the pharyngeal plexus and glosso-pharyngeal nerve; an additional branch from the external pharyngeal nerve being sent to the inferior constrictor; the palato-pharyngeus receives a branch from Meckel's ganglion.

These muscles are exercised in the act of deglutition, and also exert an influence in modulating the voice.

8. Palatal Group.

The Levator Palati.
The Tensor, or Circumflex Palati.
Constrictor Isthmi-faucium, or Palati-glossus.
Palato-pharyngeus.
Azygos-uvulæ.

The *Levator Palati* (Fig. 29) arises from the point of the petrous portion of the temporal bone and adjoining portion of the Eustachian tube, descends, and is inserted into the soft palate.

The *Tensor*, or *Circumflexus Palati*, arises from the base of the pterygoid process of the sphenoid bone and from the Eustachian tube; it descends in contact with the internal pterygoid muscle to the hamulus, round which it winds, and is inserted into the soft palate, where it expands and joins its fellow.

The *Constrictor Isthmi-faucium*, or *Palato-glossus*, occupies the anterior lateral half arches of the palate; it arises from the side of the tongue near its root, and is inserted into the velum near the uvula.

The *Palato-pharyngeus* has already been described with the muscles of the pharyngeal group.

The *Azygos Uvulæ* arises from the posterior spine of the palate bones at the termination of the palate suture, runs along the central line of the soft palate, and ends in the point of the uvula. It raises and shortens the uvula.

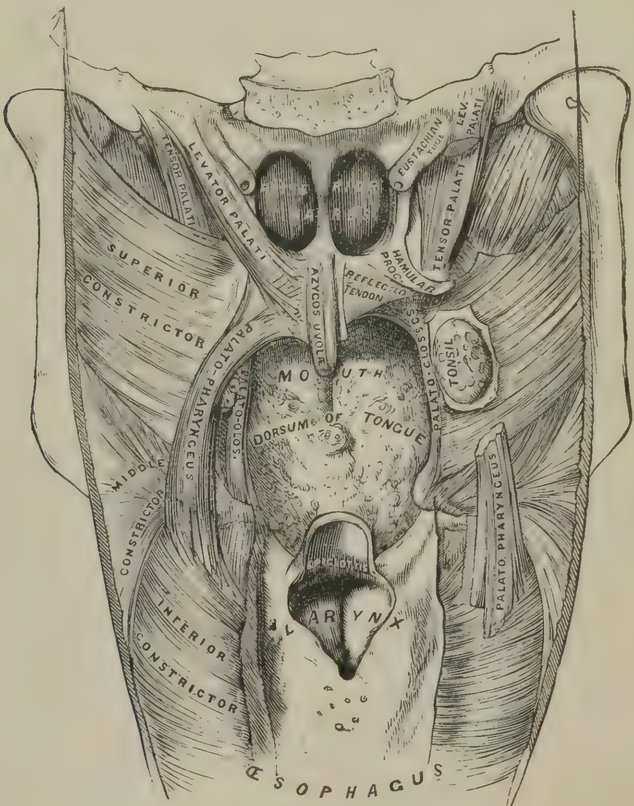

FIG. 29.

It is thus seen that the various muscles of the soft palate are all concerned, more or less, in conducting the food into the pharyngeal cavity. The elevators raise the palate, and at the same time protect the posterior nares from regurgitation of the food; while the tensor puts it on the stretch, and after it has passed the velum, the constrictor isthmi-faucium and palato-pharyngeus draw the palate down, and thus close the opening into the mouth; after which the food, as already mentioned, is grasped by the constrictor muscles of the pharynx and conveyed into the œsophagus.

The *Soft Palate* is a movable curtain, composed of mucous membrane, inclosing five muscles on each side, known as the muscles of the soft palate, namely: the levator palati, tensor palati, azygos uvulæ, palato-glossus, and palato-pharyngeus. It is situated at the back part of the mouth between this cavity and the pharynx, is connected above to the posterior edge of the hard palate, and laterally to the side of the tongue and pharynx.

By this arrangement, the soft palate has the appearance of a lunated or arched veil between the cavity of the mouth and the pharynx.

In the center of this arch an oblong body is suspended, called the uvula, which divides the soft palate into lateral half arches, that pass on either side from the uvula to the root of the tongue.

There is also seen passing from the uvula on each side to the pharynx two other arches, which, from being behind the first, are called the posterior arches or pillars.

Between the anterior and posterior pillars, on either side, is a triangular interval containing the tonsil glands.

The *Fauces* are the straits or passage leading from the mouth to the pharynx; and the space included between the soft palate above, the half arches or tonsils on either side, and the root of the tongue below, is called the isthmus of the fauces.

The *Tonsils* are two bodies, each about the size of an almond, seen at the root of the tongue on its sides, occupying the cavity between the anterior and posterior arches. They consist of a group of compound follicular glands, forming somewhat oval bodies, whose enlargement constitutes an obstacle to deglutition, and by their locality near the mouths of the Eustachian tubes frequently cause obstruction and deafness.

ARTICULATIONS.

Articulation is a term used in Anatomy to denote the various modes of union between the bones of the skeleton. Articulations are classed under three general heads, namely—movable joints, immovable joints, and joints of a mixed order, the latter being somewhat movable without much relative displacement of the contiguous surfaces. The lower jaw is an example of a movable articulation which is known as the—

Temporo-maxillary Articulation (Figs. 30 and 31).—The inferior maxillary bone articulates with the anterior portion of the glenoid cavity of the temporal bone, forming the temporo-maxillary articulation. This joint consists of the convex condyloid head or process of the inferior maxillary bone, the concave surface of the glenoid fossa, the interarticular fibro-cartilage, a double synovial membrane, and a loose capsular ligament.

The *Capsular Ligament* is a very loose sac, attached above to the circumference of the glenoid cavity, and in front to the articular root

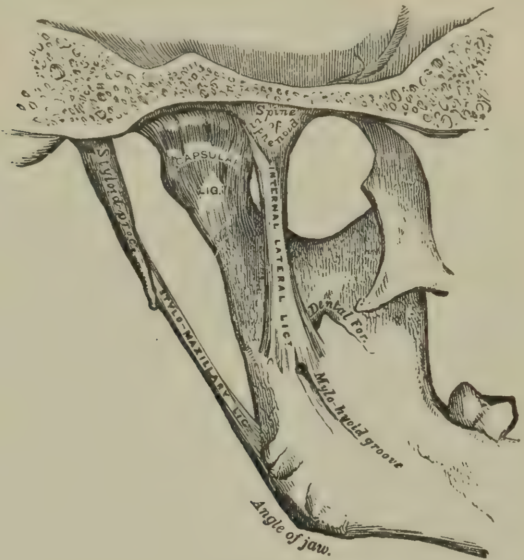

FIG. 30.

of the zygoma; below it embraces the neck of the inferior maxillary bone, immediately below the head or condyloid process.

The *Interarticular Fibro-cartilage* is an ovoid plate placed between

FIG. 31.

the bones, and is supported in position by a circumferential attachment to the common capsule, the external lateral ligament, and to the tendon of the external pterygoid muscle. Below its face is concave, corresponding with the convexity of the condyle: above it is concave

in front and convex behind, corresponding with the glenoid cavity proper and the articular eminence. The composition of the circumference is fibrous with a cartilaginous center, being frequently quite soft and sometimes perforated.

The *Synovial Membranes*, one above and the other below the interarticular fibro-cartilage, are the lubricating membranes, and in form are similar to two small sacs. They secrete the synovia, a fluid which resembles the white of an egg, but which is more oily and resistive in its nature.

The *Internal Lateral Ligament* descends from the spinous process of the great wing of the sphenoid bone, and is attached to the inner surface of the ramus.

The *Stylo-maxillary Ligament* passes behind from the styloid process of the temporal bone to be inserted just above the angle.

The *External Lateral Ligament* has its origin from the zygoma, and passes obliquely downward and backward to be inserted about the neck of the condyle; it is a short, somewhat triangular-shaped band of fibrous tissue, and assists in forming the common capsule. Externally it is very superficial, being covered only by the integuments, except in cases where the parotid gland overlaps it.

CHAPTER V.

THE ARTERIES AND VEINS OF THE MOUTH.

THE arteries that supply the mouth come from the external carotid. This is a division of the common carotid which arises on the right side from the arteria innominata, and on the left from the arch of the aorta; after passing up the neck on either side, along the course of the sterno-cleido-mastoid muscles, it divides, on a level with the top of the thyroid cartilage, into its two great branches—the external and internal carotid arteries.

The *Internal Carotid Artery* has a tortuous course; is first to the outside and behind the external carotid; then ascends in front of the vertebral column by the side of the pharynx and behind the digastric and styloid muscles to the carotid foramen in the petrous portion of the temporal bone; thence it traverses the canal in this bone and enters the brain, supplying it with most of its vessels, not giving any to the mouth.

The *External Carotid* extends from the top of the larynx to the neck of the condyle of the lower jaw; at first anterior and on the inside of

the internal carotid, it soon gets to the outside, then passes under the digastric and stylo-hyoid muscles and lingual nerve, becomes imbedded in the parotid gland, and terminates between the neck of the inferior maxilla and the auditory meatus in the temporal and internal maxillary arteries.

The branches of the external carotid with which we have to do are the—

Lingual.
Facial.

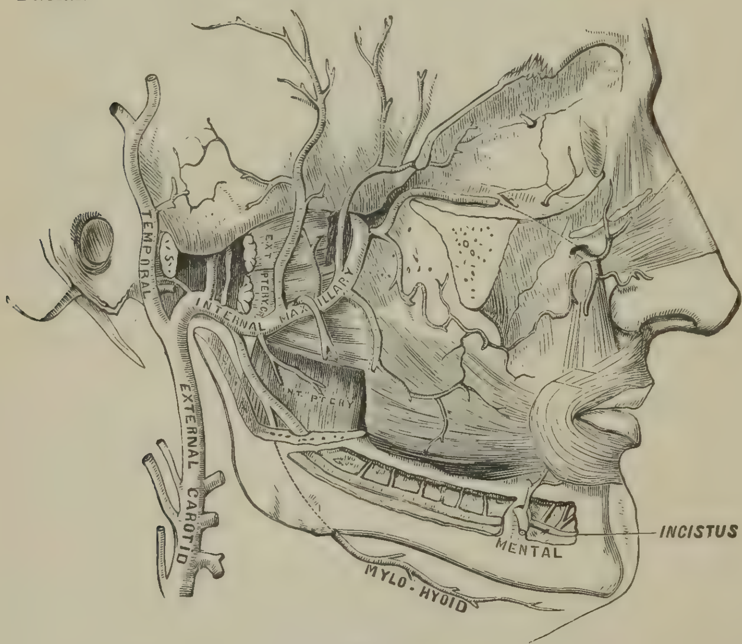

FIG. 32.

Ascending Pharyngeal.
Temporal.
Internal Maxillary.

The *Lingual Artery* arises from the external carotid, between the superior thyroid and facial; passing obliquely up to the great corner of the hyoid bone, it runs parallel with, and ascending perpendicularly to, the base of the tongue, continues its course to the tip of that organ, under the name of the ranine artery. This part of the artery lies just beneath the mucous membrane, and is in danger of being wounded in division of the frænum in children. This accident may be avoided by using blunt-pointed scissors, and directing the points downward and backward.

The hypo-glossal nerve accompanies this artery.

The branches of the lingual artery with which we are concerned are the—

Dorsalis Linguæ.

Sublingual.

Ranine.

The *Dorsalis Linguæ* arises from the lingual artery, beneath the hypo-glossus muscle, and is distributed to the tonsil, epiglottis, soft palate and mucous membrane of the tongue.

The *Sublingual* arises from the lingual at the point of bifurcation, near the anterior margin of the hyo-glossus muscle, and passes forward to be distributed to the sublingual gland, to the mucous membrane of the mouth and gums, and to the neighboring muscles.

The *Ranine* may be considered the continuation of the lingual. It passes along the inferior surface of the tongue, just beneath its mucous membrane. At the tip of the tongue it anastomoses with its fellow of the opposite side. It is accompanied by the gustatory nerve.

The *Facial Artery* is the third branch of the external carotid. It ascends to the submaxillary gland, behind which it passes on the body of the lower jaw; thence it goes in front of the masseter muscle to the angles of the mouth, and finally terminates at the side of the nose by anastomosing with the ophthalmic arteries.

In its course it gives off the submental, inferior labial, superior and inferior coronary arteries, which mainly supply the elevators, depressors, and circular muscles of the mouth. The branches of the facial artery are divided into two sets:—

Cervical Branches.	*Facial Branches.*
Inferior or Ascending Palatine.	Muscular.
Tonsillitic.	Inferior Labial.
Submaxillary.	Inferior Coronary.
Submental.	Superior Coronary.
	Lateralis Nasi.
	Angular.

The *Inferior Palatine* passes up between the stylo-glossus and stylo-pharyngeus muscle, which it supplies, to give branches to the tonsil, Eustachian tube, soft palate and palatine glands, anastomosing with the tonsillitic artery and with a branch of the internal maxillary.

The *Tonsillitic Artery* is distributed to the tonsil and root of the tongue.

The *Submaxillary* supplies the submaxillary gland, together with the neighboring lymphatic glands, muscles and integuments.

The *Submental* is the largest of the cervical branches of the facial

artery; it is given off from it just as it emerges from the submaxillary gland, and, passing along the lower border of the inferior maxilla, is distributed to the muscles attached to the jaw, and terminates in a superficial and deep branch; the former of which is distributed to the depressor labii inferioris and integument, anastomosing with the inferior labial; the latter is also distributed to the lip, and anastomoses with the inferior labial and mental arteries.

The *Facial* branches are distributed to the muscles of the face. The muscular to the pterygoid, masseter and buccinator muscles. The superior coronary to the upper lip, giving branches to the septum and ala nasi. The inferior coronary passes to the lower lip, and anastomoses with its fellow of the opposite side. The lateralis nasi supplies the wing and back of the nose. The angular is the terminal branch of the facial. It supplies the cheek, lachrymal sac and orbicularis palpebrarum muscle, and terminates by anastomosing with the ophthalmic by its nasal branch.

The *Ascending Pharyngeal*, the smallest of the external carotid branches, is given off from the posterior part of the external carotid, passes up beneath its other branches and the stylo-pharyngeus muscle to the base of the skull; it has three sets of branches—the external, meningeal and pharyngeal. To the latter only will attention be directed.

The *Pharyngeal* branches are three or four in number, two of which are distributed to the middle and inferior constrictors and to the stylo-pharyngeus, and their mucous membrane. The largest branch supplies the tonsil, Eustachian tube and soft palate, substituting the palatine branch of the facial when it is absent or of small size.

The *Temporal Artery* gives off a transverse facial branch just before it emerges from the parotid gland, which is distributed to that gland, the masseter muscle and the integument, terminating by anastomosis with the facial and infra-orbital arteries.

The *Internal Maxillary Artery* commences in the substance of the parotid gland; then goes horizontally behind the neck of the condyle of the lower jaw to the pterygoid muscles, between which it passes, and then proceeds forward to the tuberosity of the superior maxillary bone; from thence it takes a vertical direction upward between the temporal and external pterygoid muscles to the zygomatic fossa, where it again becomes horizontal, and finally ends in the spheno-maxillary fossa by dividing into several branches.

The branches of this artery which we shall describe are the—

Inferior Dental.	Alveolar.
Infra-orbital.	Descending Palatine.

The *Inferior Dental Artery* enters the inferior dental foramen of the lower jaw, passes along the dental canal beneath the roots of the teeth; sending up, in its course, a twig through the aperture of each to the pulp of the teeth, and finally escapes at the mental foramen on the chin; a branch of it, however, continues forward to supply the incisors. After emerging from the mental foramen, it supplies the muscles and integument of the chin and anastomoses with the inferior labial, submental, and inferior coronary arteries. Before entering the dental foramen a large branch, the mylo-hyoid, which lies in a groove of the same name on the inner surface of the maxillary bone and is lost on the under surface of the mylo-hyoid muscle, is given off.

The *Alveolar* is given off from the internal maxillary by a trunk common to it and the infra-orbital, just before it enters the spheno-maxillary fossa. At the tuberosity of the superior maxillary bone it divides into numerous branches, some of which, passing into the alveolar foramina, supply the bicuspid and molar teeth; others pierce the bone to supply the antrum, while some are distributed to the gums.

The *Infra-orbital Artery* enters the infra-orbital canal, traverses its whole extent, and comes out at the foramen of the same name, upon the face; just before it emerges it sends through the anterior dental canal a twig for the incisors and cuspids, having previously given branches to the inferior rectus and inferior oblique muscles and to the lachrymal gland; also other branches to the lining membrane of the antrum. After escaping from the orbit, it supplies the lachrymal sac and neighboring tissues and anastomoses with the facial, nasal branch of the ophthalmic, and with the transverse facial and buccal branch.

The *Descending Palatine* passes along the posterior palatine canal, accompanied by palatine branches of Meckel's ganglion; emerging thence it runs along a groove on the inner border of the alveoli, and is distributed to the mucous membrane of the hard palate, to the gums and the palatine glands. In the posterior palatine canal it gives off branches, which pass along the accessory palatine canal to be distributed to the soft palate. In front it terminates in a small branch which enters the anterior palatine canal, through which it passes to reach the septum naris, where it unites with a branch of the spheno-palatine.

The *Veins* correspond so nearly, both in name and course, with the arteries, that a description of them would only be a repetition of what has been said; suffice it, therefore, to observe that there are two companion veins with every considerable artery, and that the venous branches are mostly collected at the angle of the jaw into a common

trunk called the external jugular vein, which passes down the neck in the course of the fibres of the platysma muscle, and terminates in the subclavian vein at the posterior edge of the sterno-mastoid muscle.

The office of the veins is to return the blood to the heart.

CHAPTER VI.

THE NERVES OF THE MOUTH.

THE *Cranial Nerves* pass in pairs through the foramina in the base of the skull. According to the order of succession from before backward, they are known as the first, second, third, fourth, fifth, sixth, seventh, eighth, ninth, tenth, eleventh, and twelfth pairs.

The nerves supplying the mouth belong to the fifth pair, and the portio dura of the seventh pair or facial nerve.

The *Fifth* (Trigemini) is the largest of the cranial nerves, and gives sensibility to all the organs concerned in the primary stages of digestion.

This nerve will also be found to be a compound nerve, having motor filaments as well as sensitive, and thereby giving motion as well as sensation. It is also a nerve of special sense.

It is first seen at the side of the pons Varolii near its junction with the crura-cerebelli, but its origin is much deeper and further back. It arises by two unequal roots, one of which may be traced through the pons Varolii into the lateral tract behind the olivary body; the smaller, or *motor root*, is lost in the medulla oblongata. From its origins this nerve has been called a cranial-spinal nerve.

These two fasciculi, the one anterior and the other posterior, constitute the fifth nerve, which consists of eighty or one hundred filaments that pass forward and outward, in a canal formed of dura mater, to a depression on the anterior surface of the petrous bone.

At this point it spreads into a ganglion, called the Gasserian ganglion, on the under surface of which is seen the anterior root; but it has no intimate connection with the ganglion, and can be traced on, as will be presently shown, to the inferior maxillary nerve.

The Gasserian ganglion receives filaments from the carotid plexus of the sympathetic, and gives off several minute branches to the dura mater and tentorium cerebelli. Three large branches are given off from its anterior border, the ophthalmic and superior and inferior maxillary. The ophthalmic and superior maxillary are exclusively nerves of sensation, their fibres being derived entirely from the pos-

terior or sensory root, whilst the inferior maxillary receives fibres from both roots, and is consequently more variously endowed.

The *Ophthalmic Nerve* is a short trunk that enters the orbit through the foramen lacerum superius. It supplies the eyeball, the mucous membrane of the eye and nose, and the lachrymal gland, also the muscles and integument of the eyebrow and forehead. It is a sensitive nerve;

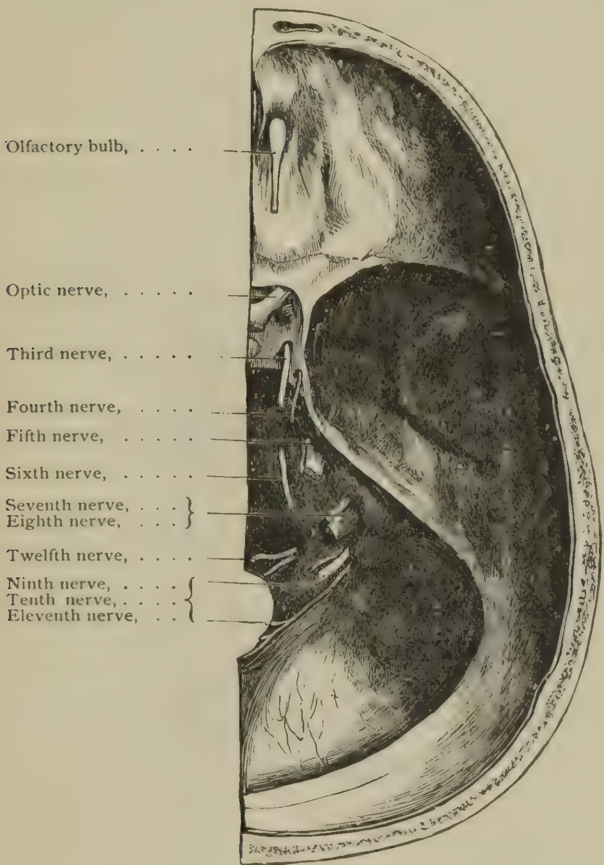

FIG. 33.—DIAGRAM OF THE EXIT OF THE CRANIAL NERVES.

is the first given off from the Gasserian ganglion, and is the smallest of the three branches. It receives a few filaments from the cavernous plexus of the sympathetic, and divides into three principal branches—

1. The Frontal,
2. The Lachrymal, and
3. The Nasal.

The *Frontal*, which is the largest branch of the ophthalmic, passes along the roof of the orbit to the supra-orbital foramen, through which it passes, and is then called the supra-orbital nerve, and is spent on the muscles and integuments of the forehead. It gives off several branches in its course.

The *Lachrymal*, the smallest branch of the ophthalmic, generally arises by two branches, one from the fourth nerve and the other from the ophthalmic. It enters the orbit through the sphenoidal

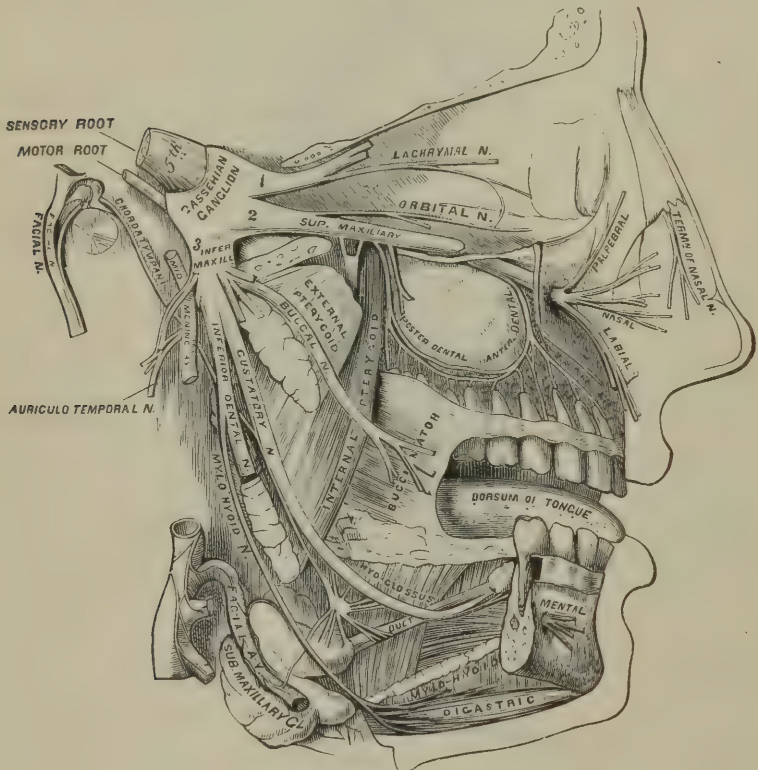

FIG. 34.

fissure, receives a communicating branch from the superior maxillary, and is finally distributed to the lachrymal gland, taking the outward direction, and sending branches in its course to the upper eyelid, conjunctiva, and other parts, receiving on the eyelid branches from the facial.

The *Nasal* takes its direction along the inner side of the orbit to the anterior ethmoidal foramen, through which it passes into the cranium, on the upper surface of the cribriform plate of the ethmoidal

bone ; descends by the side of the crista-galli through a slit-like opening into the nose, and there terminates by filaments which are spent upon the septum, mucous membrane, anterior nares, etc. It sends off several branches in its course ; one in particular to the lenticular ganglion at the bottom of the eye, others to the caruncula lachrymalis, lachrymal sac, conjunctiva, etc.; but as these do not belong to the mouth and dental apparatus, we will pass to the second great division of the fifth.

The Superior Maxillary Nerve.—This nerve proceeds from the middle of the Gasserian ganglion, passes through the foramen rotundum of the sphenoid bone into the pterygo-maxillary fossa ; here it enters the canal of the floor of the orbit—the infra-orbital canal—traverses its whole extent, and emerges on the face at the infra-orbital foramen, where it terminates in numerous filaments in the muscles and integuments of the upper lip, cheek, lower eyelid and side of the nose.

The superior maxillary nerve supplies the upper jaw, and gives off many important branches, which are as follows :—

In the pterygo-maxillary fossa two branches descend to a small reddish body called the ganglion of Meckel, or the spheno-palatine ganglion, situated on the outer side of the nasal or vertical plate of the palate bone.

From this ganglion proceed three sets of branches :—

1. Inferior, Descending or Palatine Nerves.
2. Nasal or Spheno-palatine.
3. Posterior, Pterygoid or Vidian.

The *Palatine Nerves* descend through the posterior palatine canal, come out at the posterior palatine foramen, along with an artery of the same name, and supply with filaments the soft palate, uvula, tonsils, the roof of the mouth, and the inner alveoli and gums.

The *Nasal Nerves* enter the nose through the spheno-palatine foramen, and divide into several filaments, which enter the mucous membrane covering the upper and lower turbinated bones and vomer ; one long branch can be traced along the septum nasi, as far as the foramen incisivum, where it meets the anterior palatine branches in a ganglion called the naso-palatine.

The *Vidian*, or *Pterygoid*, passes backward from the ganglion of Meckel through the pterygoid canal at the root of the pterygoid process ; then enters the cranium through the foramen lacerum anterius, and divides into two branches, one of which enters the carotid canal and unites with the sympathetic branches of the superior cervical ganglion, thus connecting this ganglion with the ganglion of Meckel.

The other, the proper vidian nerve, enters the vidian foramen or hiatus Fallopii in the petrous bone, joins the portio dura nerve, accompanies this as far as the back part of the tympanum; then leaves it, enters the cavity of the tympanum, and receives there the name of *Chorda Tympani.* It leaves this cavity by the glenoid fissure, then joins the gustatory nerve, continues with it to the submaxillary gland, where it leaves it, and is lost in the submaxillary ganglion, situated at the posterior part of the submaxillary gland.

The exceedingly intricate course of the vidian nerve is interesting from the number of communications which it establishes between different and distant parts; for it unites the ganglion of Meckel with the superior cervical ganglion of the sympathetic, and both with the submaxillary ganglion; it also connects the superior and inferior maxillary nerves to one another and to the portio dura.

The *Superior Maxillary Nerve* gives off next in the spheno-maxillary fossa—

1. The Orbital.
2. The Posterior Dental.
3. The Anterior Dental.

The *Orbital* enters the orbit through the spheno-maxillary fissure, and then sends off a *malar* and *temporal* branch, which pass out through the malar bone; the first supplying the cheek, the latter accompanying the temporal artery to the integuments of the side of the head, receiving filaments from the facial and auriculo-temporal branch of the inferior maxillary.

The *Posterior Dental Nerves*, two in number, descend on the tuberosity of the superior maxillary bone, and enter the posterior dental canals to supply the bicuspid and molar teeth; one branch penetrates the antrum and courses along the outer wall, anastomosing with the anterior dental nerves, while another runs along the alveolar border, supplying the gums.

The *Anterior Dental* is given off from the superior maxillary, just before it escapes from the infra-orbital foramen. It anastomoses with the posterior dental, and sends filaments to the incisor, canine, and first bicuspid teeth; others are sent to the mucous membrane of the inferior meatus.

This nerve now emerges, as before mentioned, at the infra-orbital foramen, between the levator labii superioris alæque nasi and levator anguli muscles, dividing here into many branches, some of which ascend to the nose and eyelids, others pass downward and outward to the lip and cheek, anastomosing with the nasal branch of the ophthalmic and the facial branches of the portio dura.

Inferior Maxillary Nerve.—This nerve forms the third great division of the fifth. It is the largest branch, and passes from the ganglion of Gasser, through the foramen ovale of the sphenoid bone, to the zygomatic fossa.

This nerve, as stated, is attached to the anterior or motor root, and they come together on the outside of the foramen ovale; then in the zygomatic fossa, the inferior maxillary nerve divides into two branches:—

1. Anterior.
2. Posterior.

The *Anterior* is the motor branch, and gives off the following filaments to the several muscles:—

1. *Masseteric*, crossing the sigmoid notch to the masseter muscle.
2. *Temporal*, anterior and posterior deep, to the temporal muscle and fascia.
3. *Buccal*, to the buccinator, external pterygoid, and temporal muscles.
4. *Pterygoid*, to the pterygoid muscles.

The *Internal* division of the inferior maxillary nerve consists of three branches, all of which are sensitive; they are:—

1. The Anterior Auricular.
2. The Gustatory.
3. The Inferior Dental.

The *Anterior Auricular* passes behind the neck of the lower jaw and in front of the meatus of the ear, and ascends through the parotid gland, over the zygoma, along with the temporal artery, and divides into anterior and posterior branches.

In its course it unites with the facial nerve, and supplies the parotid gland, the articulation of the lower jaw, the meatus, and cartilages of the ear and side of the head.

The *Gustatory Nerve*, the nerve of the special sense of taste, immediately after its origin sends a branch to the inferior dental; it then descends between the pterygoid muscles, where the chorda tympani joins it; it now passes along the ramus of the lower jaw, covered by the internal pterygoid muscle, then above the submaxillary glands, and forward above the mylo-hyoid and between it and the hyo-glossus muscles, accompanied by the duct of Wharton; and finally ascends above the sublingual gland to the lateral, inferior, and anterior parts of the tongue.

In its course, the following branches are given off by this nerve:—

"First, one or two small filaments to the internal pterygoid muscle. Second, several to the tonsils, to the muscles of the palate, to the

upper part of the pharynx, and to the mucous membrane of the gums. Third, the chorda tympani, and some accompanying filaments to form a plexus, which supplies the submaxillary gland. Fourth, a few branches which descend along the hyo-glossus muscle to communicate with the ninth or lingual nerve. Fifth, a fasciculus of nerves to the sublingual gland and to the surrounding mucous membrane. Lastly, at the tongue it divides into several branches; some pass deep into the tissue of this organ; others, firm and soft, rise toward its surface, and are lost in the mucous membrane and in a small conical papilla near its tip."

The *Inferior Dental Nerve* passes between the pterygoid muscles, then along the ramus of the lower jaw under the pterygoideus internus to the inferior dental foramen, which it enters along with an artery and vein; it now traverses the inferior dental canal, sending twigs into all the roots of the molars and bicuspids. Opposite the mental foramen it divides into two branches; the smaller is continued forward in the substance of the jaw to supply the roots of the cuspids and incisors; while the larger comes out at the mental foramen, is distributed to the muscles and integuments of the lower lip, and finally communicates with the facial nerve.

The inferior dental, just as it enters the posterior dental foramen, gives off the *mylo hyoid* nerve; this passes forward in a groove of the lower jaw, and supplies the mylo-hyoid and digastric muscles, and occasionally the submaxillary gland.

The Facial Nerve.—The seventh or facial nerve (*portio dura*) is the last nerve to be noticed as particularly belonging to the mouth.

This nerve arises from the medulla oblongata between the olivary and restiform bodies, close behind the lower margin of the pons Varolii; it then passes forward and outward with the portio mollis to the foramen auditorium internum, which it enters and passes on to the base of this opening; here these two nerves separate, the portio mollis going to the labyrinth of the ear, while the facial enters the aqueduct of Fallopius, in which it is joined by the vidian. Within the aqueductus Fallopii it gives off two branches—the tympanic and chorda tympani. The former supplies the stapedius muscle. The latter passes along a distinct canal and enters the cavity of the tympanum near the attachment of the membrana tympani, where it is covered by mucous membrane. It escapes from this cavity by the inner side of the Glaserian fissure; after receiving a communicating branch from the gustatory nerve it passes to the submaxillary gland, then joining the submaxillary ganglion it is lost in the lingual muscle. The facial then goes in a curved direction outward and backward behind the tympanum, where it parts with the vidian, and proceeds on

to the stylo-mastoid foramen, from which it emerges. At this point it sends off three small branches:—

1. The Posterior Auricular,
2. The Stylo-hyoid, and
3. The Digastric.

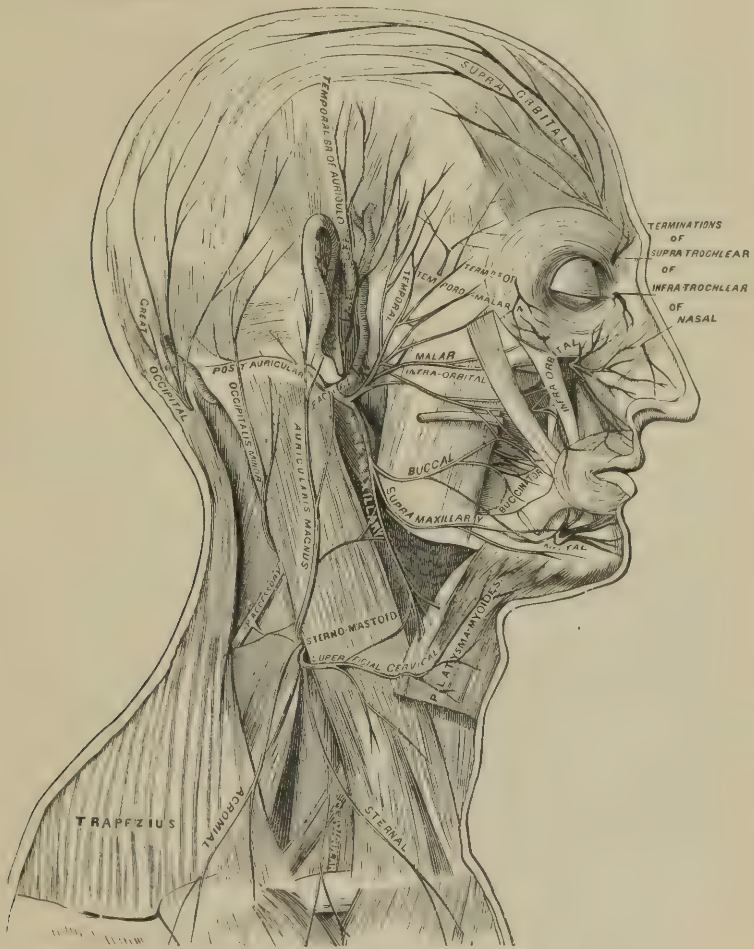

FIG. 35.

The *Posterior Auricular* ascends behind the ear, crosses the mastoid process, where it receives branches from the pneumogastric, and the auricularis magnus; it then divides into two branches, one of which passes to the retrahens aurem, the other to the occipito-frontalis muscle.

The *Stylo-hyoid* is distributed to the stylo-hyoid muscle. It communicates with filaments of the sympathetic sent to the carotid artery.

The *Digastric* is distributed to the posterior belly of the digastric muscle, receiving a communicating branch from the glosso-pharyngeal.

The facial nerve, while deeply imbedded in the substance of the parotid gland, divides into two sets of branches, of which one is superior and the other inferior; these two, by frequent unions, form the *pes anserinus* or *parotidean plexus*, and send branches to the whole of the side of the face.

The upper division, called the temporo-facial, ascends in front of the ear upon the zygoma, accompanies the temporal artery, and its branches, supplying the side of the head, ear, and forehead, and anastomosing with the occipital and supra-orbital nerves; a set of branches pass transversely to the cheek, furnishing the lower eyelid, lips, and side of the nose, and uniting with the infra-orbital nerve.

The inferior or cervico-facial division descends, supplying the lower jaw and upper part of the neck, giving off the following branches:—

1. Buccal.
2. Inferior Maxillary, and
3. Cervical.

The *Buccal*, or superior branches, supply the muscles of the cheek, nose, and upper lip.

The *Inferior Maxillary* nerves are distributed in the muscles of the chin and lower lip, and by means of anastomotic branches communicate with the inferior dental nerve.

The *Cervical* branches form a close connection with the superior cervical nerves, and supply the platysma myoid and the levator labii superioris muscles.

The facial is the motor nerve of the face, and by its means the passions or emotions find their expression in the peculiar action of the muscles to which it is distributed.

In consequence of the numerous communications which this nerve has with other nerves, the name of *Sympatheticus Minor* has been given to it by some anatomists.

Mr. Gray furnishes the following concise statement of these communications :—

In the internal auditory meatus, . . .	With the auditory nerve.
In the aqueductus Fallopii, ...	With Meckel's ganglion by the large petrosal nerve. With the optic ganglion by the smaller petrosal nerve. With the sympathetic on the middle meningeal by the external superficial petrosal nerve.
At its exit from the stylo-mastoid foramen, ...	With the pneumogastric. " " glosso-pharyngeal. " " carotid plexus. " " auricularis magnus. " " auriculo-temporal.
On the face, ...	With the three divisions of the fifth.

CHAPTER VII.

SALIVARY GLANDS AND SALIVA.

THE Salivary Glands are six in number, three on each side of the face, named the *Parotid*, *Submaxillary* and *Sublingual.*

These glands are the prime organs in furnishing the salivary fluids to the mouth during the process of mastication.

The *Parotid Gland* (Fig. 36), so called from its situation near the ear, is the largest of the salivary glands. Its form is very irregular; it fills the space lying between the ramus of the inferior maxilla and mastoid process of the temporal bone, as far back as, and even behind, the styloid process of the same bone. Its extent of surface is from the zygoma above to the angle of the lower jaw below, and from the mastoid process and meatus behind to the masseter muscle in front, overlapping its posterior portion. It weighs between five and eight drams, and is separated from the submaxillary gland by the stylo-maxillary ligament; but sometimes the two glands are continuous.

This gland is one of the conglomerate order, and consists of numerous small lobes connected together by cellular tissue, each of which may be considered a small gland in miniature, as each is supplied with an artery, vein and excretory duct.

This gland thus formed presents on its external surface a pale, flat and somewhat convex appearance.

It is covered by a dense, strong fascia, extending from the neck, and

attached to the meatus externus of the ear, which sends countless processes into every part of the gland, separating its lobules and conducting the vessels through its substance.

The use of this gland is to secrete or separate from the blood the greater part of the saliva furnished to the mouth. As the parotid is, however, on the outside, and at some little distance from the mouth, it is furnished with a duct to convey its fluid into this cavity; this duct is called the duct of Steno, or the parotid duct. It is formed of

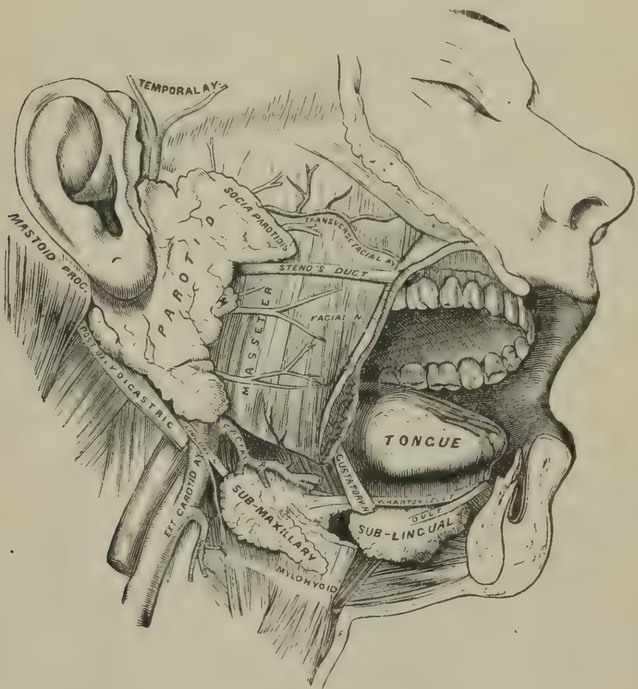

FIG. 36.

the excretory ducts of all the granules composing this gland, which, successively uniting together, at last form one common duct.

The duct of Steno commences at the anterior part of the gland and passes over the masseter muscle, on a line drawn from the lobe of the ear to the middle part of the upper lip; then passes through a quantity of soft adipose matter, and finally enters the mouth by passing through the buccinator muscle and mucous membrane, opposite the second molar of the upper jaw.

The diameter of this duct is about that of a crow-quill, but its orifice is small and contracted, and is concealed by a fold of mucous mem-

brane. It is thick and strong, and is more exposed to injury than the duct of the submaxillary gland.

The arteries supplying the parotid gland are from the external carotid or some of its branches.

The nerves are derived from the carotid plexus of the sympathetic; and from the facial, temporal, and great auricular.

The parotid secretion is a clear, watery, alkaline liquid, which is poured out abundantly during mastication, but in very small quantity when the mouth is at rest. Its secretion may also be excited by mental emotion, as when observing a savory article of food, or by artificial stimuli, as of glass beads or other irritants in the mouth.

The following analysis is taken from Dalton's Physiology :—

COMPOSITION OF HUMAN PAROTID SALIVA.

Water,	983.308
Organic Matter precipitable by alcohol,	7.352
Substance destructible by heat, but not precipitated by alcohol or acids,	4.810
Sulpho-cyanide of Sodium,	0.330
Phosphate of Lime,	0.240
Chloride of Potassium,	0.900
Chloride of Sodium and Carbonate of Soda,	3.060
Total,	1000.000

It will be seen that the quantity of organic matter is comparatively large.

Observation has shown that this secretion is unilateral, the saliva flowing only from that side on which mastication is then being conducted, and that the quantity is directly related to the physical character of the food, and not to its chemical constitution, being more or less abundant, according to the dryness of the food.

The *Submaxillary* is the next in size of the salivary glands. It is situated under and along the inferior edge of the body of the lower jaw, and is separated from the parotid by the stylo-maxillary ligament.

The submaxillary gland is partially concealed by the jaw when the head is in the natural position, and weighs about two drams. It is divided into several lobes, and the facial artery occupies a groove on its deeper surface, and also upon its upper border.

It is of oval form, pale color, and, like the parotid, consists in its structure of small lobules, held together by cellular tissue; each having a small excretory duct, which, successively uniting with one another, finally form one common duct. This, the duct of Wharton, passes above the mylo-hyoid muscle, and running forward and inward, enters the mouth below the tip of the tongue at a papilla seen on either side of the frenum linguæ.

The use of this gland is the same as the parotid, to secrete a fluid constituent of the saliva, and its duct is the route by which it is conducted into the mouth. Its arteries are derived from the facial and lingual. The veins correspond. Its nerves are received from the submaxillary ganglion, the inferior dental and sympathetic nerves.

The *Sublingual Glands* are the last in order of the salivary glands, and the smallest in size.

They are situated beneath the anterior and lateral parts of the tongue, are covered by the mucous membrane, and rest upon the mylo-hyoid muscle. Each sublingual gland is oblong in shape and weighs about one dram.

The Sublingual Glands, like the two glands just described, consist of a lobular structure with excretory ducts; which, however, do not unite into one common duct, but enter the cavity of the mouth by many ducts (ducts of Rivinius), from eight to twenty in number, whose openings are through the mucous membrane between the tongue and the inferior cuspid and bicuspid teeth.

These ducts terminate by minute openings behind the orifice of the submaxillary duct along the ridge upon the floor of the mouth. One or more of these ducts enter the submaxillary duct, and one is known by the name of the *duct of Bartholin.*

Their office is the same as the parotid and submaxillary. Their arteries are derived from the sublingual and submental. Their nerves from the gustatory; salivary glands are found in all vertebrate animals except fishes.

The *Saliva*, or oral fluid, consists of the commingled secretion of all these glands. It is a glairy, slightly opalescent, alkaline fluid, consisting of organic and mineral substances held in solution with water. Its composition, according to Bidder and Schmidt, is as follows:—

COMPOSITION OF THE ORAL FLUID.

Water,	995.16
Organic Matter,	1.34
Sulpho-cyanide of Potassium,	0.06
Phosphate of Soda, Lime, and Magnesia,	.98
Chlorides of Sodium and Potassium,	.84
Mixture of Epithelium,	1.62
	1000.00

Two kinds of organic matter exist in the saliva; the first, which is found in the submaxillary and sublingual secretions, is called *ptyaline;* to it the saliva owes its viscidity. Alcohol coagulates it, but heat does not, differing, in this respect, from the organic matter derived from the parotid gland, which is coagulated by heat and is not viscid.

Sulpho-cyanogen, the only mineral ingredient that is peculiar to saliva, is detected by a solution of the chloride of iron, with which it strikes a red color characteristic of it.

When saliva has stood for some time it deposits a whitish flocculent sediment, which is found under the microscope to consist of epithelium scales, and other nucleated cells, granular matter, and oil globules. Although saliva possesses the power to change the starchy matter of the food into sugar, yet in view of the facts that this change is interrupted by the gastric juice with which it is so soon to come in contact, and that the quantity secreted is directly related to the physical characteristics of the food, and not to its chemical constitution, not being more abundant during the mastication of starchy food, except it be dry, than of any other aliment, and, furthermore, since the conversion of starch into sugar is otherwise provided for, it may be considered an established fact that its only purpose is to aid mechanically in mastication and deglutition by moistening and lubricating the food. The quantity of saliva secreted daily has been variously estimated by different observers. Mitscherlich thought it about fourteen ounces daily, and Todd and Bowman consider his estimate reliable. Bidder and Schmidt estimated it at about three and a half pounds avoirdupois, and Mr. Dalton at "rather less than three pounds avoirdupois," which is probably very nearly correct.

The *Mucous Glands.*—Besides the glands furnishing the saliva, there is another series of much smaller size, called the *mucous glands.* They are simply the little crypts, follicles, or depressions everywhere found in the mucous membrane of the mouth, and named, according to their situation, the glandulæ labiales, glandulæ buccales, etc. The lips, cheeks, and palate are also furnished with glands about the size of a small pea, which present the true salivary structure.

The use of these glands is to furnish the mucus of the mouth, which they pour into this cavity by single orifices, opening everywhere on its surface.

The *Buccal Glands* in structure resemble the salivary, and also the labial found beneath the mucous membrane of the lips, though somewhat smaller than the latter. The buccal glands are situated between the buccinator muscle and the mucous membrane.

The *Molar Glands*, three or four in number, are situated between the masseter and buccinator muscles, and their secretion, which is mucous, is conveyed to the mouth by ducts which open near the third molar teeth.

CHAPTER VIII.

THE TONGUE.

THE *Tongue* is a very complicated organ; it consists of a great variety of parts, and performs a great variety of functions; it is one of the organs of deglutition; a glandular organ, to secrete; a sentient organ, to feel and taste; and likewise an intellectual organ, to assist in producing speech.

FIG. 37.—"UPPER SURFACE OF THE TONGUE" WITH THE FAUCES AND TONSILS.
1. Papillæ circumvallatæ. 2. Papillæ fungiformes.

The tongue is divided into apex, body, and root; the apex is the anterior free and sharp portion; the root, which is thin, is attached to the os hyoides and is posterior; while the body, which occupies the center, is thick and broad; it is confined in its situation by the origin of its component muscles and by reflections of the mucous membrane.

The mucous membrane of the tongue covers its free surface everywhere; it is thinnest on its under surface, where it may be traced along the ducts of the submaxillary and sublingual glands. Passing over the dorsum, it assumes a papillary character, and becomes much thickened.

The papillæ of the tongue are the papillæ circumvallatæ, papillæ fungiformes, and papillæ filiformes.

The papillæ circumvallatæ (maximæ) are situated on each side of the back part of the tongue, meeting at the foramen cæcum so as to form a triangular figure. They number from eight to fifteen.

Each papilla is arranged in the form of an inverted cone, with its apex received into a depression of mucous membrane, and its base exposed on the free surface, and upon it may be seen numerous smaller papillæ.

The papilla fungiformes are scattered irregularly over the surface of the tongue, but are most numerous at its sides and apex. They also are studded on their free surface with smaller papillæ.

The papillæ filiformes are found on the anterior two-thirds of the tongue, and are very minute. They are somewhat conical or filiform in shape, are covered with an unusually dense epithelium, which gives them a whitish appearance, and are filled with secondary papillæ. Small hairs are often found in them.

Structure of the Papillæ.—They consist of papillary loops, through which nerves are abundantly distributed, covered by a homogeneous tissue, upon which is superposed a thick layer of squamous epithelium.

The nerves are large and numerous in the papillæ circumvallatæ; in the papillæ fungiformes and papillæ filiformes they are smaller.

In the mucous membrane are also found follicles or glands. The former are very numerous, especially so between the circumvallate papillæ and the epiglottis, but are found scattered over the entire surface of the tongue. The latter, called mucous or lingual glands, are most abundant on the posterior third of the tongue, but are found also on its tip, sides, and in the neighborhood of the circumvallate papillæ. The ducts open on the free surface of the mucous membrane.

THE MUCOUS MEMBRANE LINING THE MOUTH.

The whole interior cavity of the mouth, palate, pharynx, and lips is covered by mucous membrane, forming folds or duplicatures at different points, called frenæ, or bridles. Beginning at the margin of the lower lip, this membrane can be traced lining its posterior surface, and from thence reflected on the anterior face of the lower jaw, where it forms a fold opposite the symphysis of the chin—the frenum of the lower lip; it is now traced to the alveolar ridge, covering it in front, and passing over its posterior surface, where it enters the mouth. Here it is reflected from the posterior symphysis of the lower jaw to the under surface of the tongue, where it forms a fold or bridle, called the *frenum linguæ*. It now spreads over the tongue, covering its dorsum and sides to the root, from whence it is reflected to the epiglottis, forming another fold; from this point it can be followed, entering the glottis and lining the larynx, trachea, etc.

In the same way, commencing at the upper lip, it is reflected to the upper jaw, and at the upper central incisors, forming a fold, the *frenum* of the upper lip; from this it passes over the alveolar ridge

to the roof of the mouth, which it completely covers, and extends as far back as the posterior edge of the palate bones; from this it is reflected downward over the soft palate, or, more strictly speaking, the soft palate is formed by the duplicature of this membrane at this point, between the folds of which are placed the muscles of the palate already described.

From the palate it is traced upward and continuous with the membrane lining the nares, and downward with the same, lining the pharynx, esophagus, stomach, and intestinal canal.

The mucous membrane, after entering the nostrils and lining the roof, floor, septum nasi, and turbinated bones, enters the maxillary sinus, between the middle and lower spongy bones, and lines the whole of this great and important cavity of the superior maxilla.

Many mucous glands or follicles, already enumerated, are scattered over the whole of this membrane, and furnish the mouth with its mucus.

The mucous membrane of the mouth, which is directly concerned in the development of the teeth, and afterward is in close relation with these organs, is composed of different layers, as follows:—

Epithelium. $\begin{cases} \text{Corneous.} \\ \text{Malpighian.} \end{cases}$

Basement Membrane.

Corium, or Proper Mucous Membrane. $\begin{cases} \text{Papillary.} \\ \text{Reticulary.} \end{cases}$

Submucous Areolar Tissue.

The epithelium, which corresponds to the epidermis of the skin, and is derived from the same source, is composed of two layers, an external and an internal. The external layer, of horny consistence, and known as the corneous layer—*stratum corneum*—is formed of old epithelial cells, which, owing to changes from prismatic or columnar cells during their migration from the internal to the external surface of the membrane, have become thin, devitalized scales, devoid of function. These old epithelial cells are being continually cast off as effete matter, others taking their places, which in turn undergo a similar process of devitalization and exfoliation.

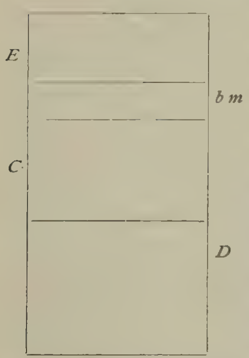

FIG. 38.—DIFFERENT LAYERS OF MUCOUS MEMBRANE.
E. Epithelium. *b m.* Basement membrane. *C.* Corium. *D.* Submucous areolar tissue.

The epithelium of the mouth is analogous in form to the skin, and the slight modification is due to its immersion in the oral fluids, which prevents its external

layer from assuming the horn-like or corneous nature of the same layer of the skin. The epithelial cells are united in layers by an intercellular cement-substance, and the superficial layer, which is composed of thin scales or discs, contains nuclei, differing, in this respect, from the corneous layer of the skin, which does not usually contain nuclei.

The internal or Malpighian layer is formed of living epithelial scales or cells, which are of various forms and sizes, and are placed vertically upon the "basement membrane," which separates the epithelium from the corium (proper mucous membrane). The cells of this internal layer are variously designated as the prismatic, columnar, cylindrical, or Malpighian layer, and have large nuclei, but are destitute of a cell-wall. This layer constitutes the perpetual

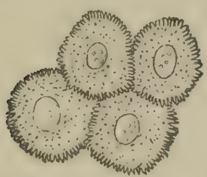

FIG. 39.—CELLS COMPOSING THE STRATUM CORNEUM OR EXTERNAL LAYER OF EPITHELIUM (*from Frey*).

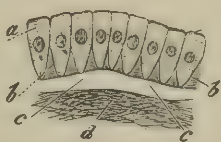

FIG. 40.—INTERNAL OR MALPIGHIAN LAYER OF THE EPITHELIUM. *a.* Infant cells, known as prismatic, columnar, or cylinder cells. *b.* Intermediate matter. *d.* Fibrous tissue of the corium.

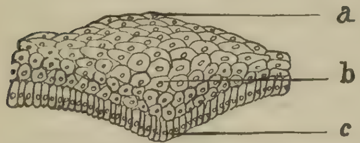

FIG. 41.—*a.* Flat layer of epithelial cells thrown upward into the "burrelet" of Legros and Magitot. *b.* Enlargement and proliferation of cells in cuboidal layers, forcing flat layer upward and columnar layer downward. *c.* Columnar layer of cells directly over position which will be occupied by future jaw.

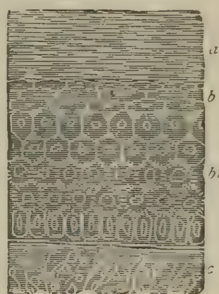

FIG. 42.—*a.* Stratum corneum. *b.* Stratum Malpighii. *bm.* Basement membrane. *c.* Corium.

portion of the enamel organ, which during the development of a tooth is known as the "enamel membrane."

The basement membrane, known as the *membrana præformativa* of Raschow, is situated below the internal or Malpighian layer, and is a homogeneous structure, which in some parts partakes of the character of a membrane, especially where it is of considerable thickness.

Although not usually recognized as a layer of mucous membrane, yet it is interesting from the fact that the dentine bulb or germ and the enamel organ are found on the opposite sides of it, the former below and the latter above it.

The Corium or *mucosa*, which is the proper mucous membrane, is

situated beneath the basement membrane, and is analogous to the derma of the skin. It consists of a fibro-vasoular layer of variable thickness, merging into the submucous areolar tissue, and contains, besides the white and yellow fibrous tissue and the vessels, muscular fibre cells (forming what is known in some localities as the *muscularis mucosæ*), nerves and lymphatics.

Mucous glands project from its surface, and with the processes known as villi and papillæ, common to mucous membrane covering the tongue, are analogous to the papillæ of the skin.

THE GUM.

The gum is composed of dense, elastic, fibrous tissue, adhering to the periosteum of the alveolar tissue. It is remarkable for its insensibility and hardness in the healthy state, but exhibits great tenderness upon the slightest injury when diseased. The gum differs in texture from that of the mucous membrane lining the inside of the lips, covering the floor of the mouth and the palate, of which it is a continuation, by being thicker and denser, and of less sensibility. Its hardness is due, in a great measure, to the numerous tendinous fasciculi in its substance, and also to its being closely blended with the dense fibrous fasciculi of the periosteum, which causes it to closely adhere to the bone. These fasciculi of the gum, arising from the periosteum, expand in fan-like form as they approach the epithelial surface. The substance of the gum contains broad-based papillæ, either single or compound, and the epithelium is formed of laminæ of tessellated cells, very much flattened near the surface, but with cylindrical cells composing the Malpighian or deepest layer. The gums are very vascular, being freely supplied with vessels, but with few nerves. A free margin of gum, about half a line in width, surrounds the base of each tooth, and they present a festooned appearance, caused by elongations in the interdental space. The portion of the gum which adheres to the neck of the tooth is of a very fibrous structure. At the necks of the teeth the gum is continuous with the periosteum of the inner surface of the alveoli, being reflected back upon itself, and uniting with the true peridental membrane. The gum of the upper jaw is supplied with vessels from the superior coronary artery, and that of the lower jaw from the submental and sublingual arteries. They derive their nerves from the superior dental branches of the fifth pair.

In the infant state of the gum, the central line of each dental arch presents a white, firm, cartilaginous ridge, which gradually becomes thinner as the teeth advance; and in old age, after the teeth drop

out, the gum again resumes somewhat its former infantile condition, showing "second childhood."

The gum, being endowed with a high degree of vascularity, indicates very correctly, the state of the constitutional health.

THE PERIDENTAL MEMBRANE.

The Peridental Membrane lines the *alveolar cavities* or sockets, of the teeth, covers the roots of each, is attached to the gums at the necks, and to the blood-vessels and nerves where they enter the roots of the teeth at their apices; and, further, Mr. Thomas Bell believed it passes into the cavities of the teeth, forming their lining membrane, and is continuous with or the same as that of the pulp.

Mr. Charles Tomes, in describing this membrane, says: "It is thicker near to the neck of the tooth, where it passes by imperceptible gradations into the gum and periosteum of the alveolar process, and near to the apex of the root. The general direction of the fibres is transverse—that is to say, they run across from the alveolus to the cementum, without break of continuity, as do also many capillary vessels; a mere inspection of the connective-tissue bundles, as seen in a transverse section of a decalcified tooth in its socket, will suffice to demonstrate that there is but a single 'membrane,' and that no such thing as a membrane proper to the root and another proper to the alveolus can be distinguished; and the study of its development alike proves that the soft tissue investing the root and that lining the socket are one and the same thing; that there is but one 'membrane,' namely, the alveolo-dental periosteum. At that part which is nearest to the bone the fibres are grouped together into conspicuous bundles; it is, in fact, much like any ordinary fibrous membrane. On its inner aspect, where it becomes continuous with the cementum, it consists of a fine network of interlacing bands, many of which lose themselves in the surface of the cementum. But although there is a marked difference in histological character between the extreme parts of the membrane, yet the markedly fibrous elements of the outer blend and pass insensibly into the bands of the fine network of the inner part, and there is no break of continuity whatever. At the surface of the cementum it is more richly cellular, and here occur abundantly large, soft, nucleated plasm masses, which are the osteoblasts concerned in making cementum, and which, by their offshoots, communicate with plasm masses imprisoned within the cementum." According to Wedl, the vascular supply of the peridental membrane is derived from the gums, the vessels of the bone, and the vessels destined for the pulp of the tooth, the last being the most important. The nerves supplying this membrane are derived from the dental pulp and

from the nerves of the bone; hence it is apparent that the relationship between the pulp and peridental membrane of the teeth is very intimate.

ANATOMICAL RELATIONS OF THE MOUTH.

The mouth has many interesting anatomical relations with the rest of the body, a few of which it may be well to mention.

By means of its lining mucous membrane it is connected, through continuity of structure, with the pharynx, œsophagus, stomach, and the whole of the intestinal canal, etc.

Disease still further establishes this structural relation. Inflammation, ulceration, or any other pathological change in the stomach or intestines, is felt and reported on the tongue, gums, and other parts of the mouth, showing the sympathy and close relationship of these several parts.

The mouth is also connected by the same mucous membrane with the organs of respiration, by being continued down into the larynx, trachea, and bronchi.

Widespread sympathies are established between the mouth and other parts by means of the numerous nerves which animate the parts constituting its boundaries and lying in its cavity, as the sympathetic, the seventh, the glosso-pharyngeal, the par vagum, the hypoglossal, and upper cervical.

Simple irritation from teething has thrown children into convulsions, and in adults toothache often creates extreme irritability of the whole nervous system. But it is not necessary to dwell here on the sympathies of the mouth in disease with other parts of the body, as the author will have occasion to do this in other parts of this work.

It will be well, however, to mention in this place that there is a general anatomical relation of the mouth with the rest of the body, by means of the blood-vessels and areolar tissue.

PHYSIOLOGICAL RELATIONS OF THE MOUTH.

It has been shown that the mouth consists of a great variety of parts, and, also, that it has an equally great diversity of functions.

The functions of the mouth have been stated to be those of prehension, mastication, insalivation, and deglutition.

These functions, it has been seen, are all closely related to one another and mutually dependent; and how beautiful is the harmony of action as well as its regular and orderly succession! We see, in the first place, the prehensile instruments laying hold of and introducing the food into the mouth; then the organs of mastication, the teeth and upper and lower jaw bones, put into operation by the temporal, masseter, and pterygoid muscles, grind it down into minute portions;

these, at the same time, are formed into a bolus by being mixed with the salivary fluids furnished by the parotid, submaxillary, and sublingual glands; then the mass is taken by the organs of deglutition, namely, the tongue, palate, and pharynx, and passed into the œsophagus, to be thence conducted into the stomach, thus demonstrating the harmony existing among the several functions belonging to the mouth.

But the functional relation of the mouth is no less extensive than its structural relation; the one is commensurate with the other; and as the structure of the mouth has been shown to be continuous with that of other parts of the body, so we find that the functions of the mouth exert an influence upon, and are themselves influenced by, many great and leading functions of the body. The connection between mastication and insalivation, for example, with stomachal digestion, or chymification, is especially obvious.

Again, the mouth is intimately related with the intellectual functions, as, for instance, that of speech. Who does not know that when any of the teeth are wanting, the palate cleft, or there is a hare-lip, how much the speech is impaired? And so with all the other functions of the body; the relations between them and the mouth, and the mutual dependence of each on the other, is equally demonstrable.

CHAPTER IX.

THE TEETH.

The teeth in the human mouth are the prime organs of mastication, are the hardest portion of the body, and are implanted in the alveolar cavities of both the upper and lower jaw.

A tooth is composed of four distinct structures: 1. The *pulp*, occupying the chamber in the crown and the canal extending through the root; 2. The *dentine*, which constitutes the principal part of the organ; 3. The *enamel*, which forms the covering and protection of the crown; 4. The *cementum*, or *crusta petrosa*, which covers the root. (See Fig. 43.)

Two sets of teeth are developed in the mouth, one of first dentition and one of second dentition.

The teeth of first dentition, termed the milk, temporary, or deciduous teeth, are designed merely to supply the wants of childhood, and are replaced with a larger, stronger, and more numerous set. The teeth

of second dentition are termed the permanent or adult teeth, and are intended to continue through life.

The anatomical divisions of a tooth are: 1. The crown, or exposed part, situated above the gum; 2. The root, occupying the alveolar cavity, or socket; 3. The neck, which is the constricted portion between the crown and root.

THE TEMPORARY TEETH.

The temporary teeth (Figs. 44 and 45) are divided into three classes: first, the incisors; second, the cuspids, or canine teeth; third, the molars, which are succeeded by the bicuspids, or premolars, which are not represented in the temporary set.

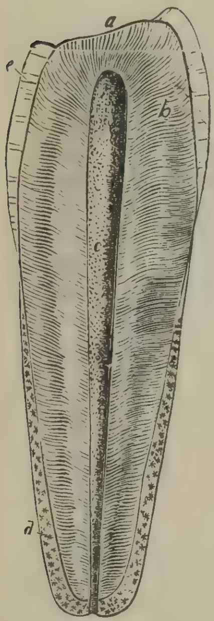

FIG. 43.—*a*. The coronal surface divested of enamel. *b*. The dentine. *c*. The pulp cavity. *d*. The cementum, or crusta petrosa. *e*. The enamel.

The temporary teeth are twenty in number, ten in each jaw, namely: four incisors, two cuspids, and four molars.

The incisors of the upper jaw are implanted in the pre-maxillary bones, which early in life unite with the maxillaries.

The pulp-cavity in a temporary tooth is also larger in proportion to the size of the organ

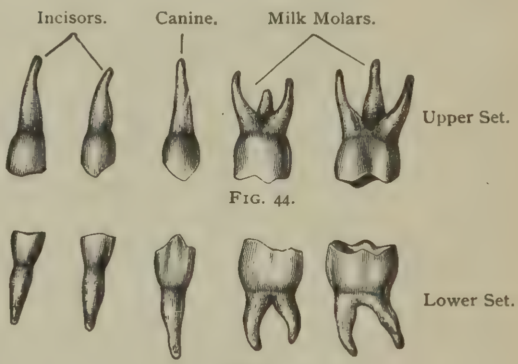

FIG. 44.

FIG. 45.

than in a permanent tooth. The pulp-cavities of the central and lateral incisors are of the same general shape, like that of an elongated tube, while those of the canines and molars correspond with the form of these teeth.

THE PERMANENT TEETH.

There are thirty-two teeth in the permanent set, sixteen to each jaw—being an increase of twelve over the temporary, designated as follows: incisors, four; cuspids, two; bicuspids, or premolars, four;

molars, six—in each jaw. The surfaces of the teeth covered by the lips are called "labial;" by the cheeks, "buccal;" toward the roof of the mouth on the upper jaw, "palatal;" toward the tongue on the lower jaw, "lingual." The name "proximate" is given to the surfaces next to each other; the surfaces looking toward the center are called "mesial;" and those looking from the center, "distal."

DESCRIPTION OF TEETH BELONGING TO EACH CLASS.

Each tooth, as has already been remarked, has a body or crown, a neck, and a root or fang. In describing these several parts, we shall begin with

The *Incisors* (four to each jaw, and so-called from the Latin word *incidere*, to cut, on account of their sharp, cutting edges (Figs. 46

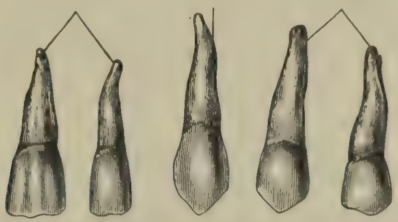

FIG. 46.—UPPER INCISORS, CANINES, AND BICUSPIDS.

FIG. 47.—LOWER INCISORS, CANINES, AND BICUSPIDS.

and 47). They occupy the anterior central part of each maxillary arch. The body of each is wedge-shaped—the anterior or labial surface is convex and smooth; the posterior or palatal is concave, and presents a tubercle near the neck; the palatal or labial surfaces come together and form a cutting edge. In a front view, the edge is generally the widest part; it diminishes toward the neck, and continues narrowing to the extremity of the root.

The crown of an incisor has four surfaces: two *proximate*, or *mesial* and *distal*, the mesial toward the median line and the distal away from the median line, one *labial*, and one *palatal*, or *lingual*—the term *palatal* being applied to the inner surface of an upper, and *lingual* to

the inner surface of a lower, incisor. It also has four angles: namely, a *right* and a *left labio-proximate* and a *right* and *left palato-proximate*, or *lingua-proximate*.

The two large incisors which are situated one on each side of the median line are termed the central incisors; the other two, the lateral incisors, or laterals, because they occupy a position on either side of the centrals. The crowns of the upper central incisors are about four lines in breadth, and the laterals three. In the lower jaw, the crowns of the central incisors are only about two lines and a half in width, while the laterals are usually a little wider. But the width of the crowns of all the incisors varies in different individuals.

The length of a superior central incisor is usually about one inch, and that of a lateral is half of a line less. In the lower jaw the central incisors are only about ten lines in length; the laterals are about one line and a half longer.

The length of the crown of an incisor is exceedingly variable. That of an upper central varies from four and a half to six lines; and there is the same want of uniformity in this respect with the crowns of all the incisors.

The superior central incisors are somewhat more prominent than the lateral incisors, owing to the curve of the alveolar process. The newly-erupted incisors have three points or cusps on their cutting edges, which soon disappear through wear, leaving such edges smooth and uniform. The labial aspect of the crown of a superior central incisor is convex, and the vertical diameter is greater than the transverse. Of the lateral surfaces, the mesial is generally flat, while the distal is more rounded. The lateral incisors are more slender in shape and smaller than the central incisors, but have the same general form, with somewhat more convexity of the labial surface.

The roots are all single, of a conical form, flattened laterally, and slightly furrowed longitudinally. Those of the lateral incisors (Figs. 46 and 47) are more flattened laterally than the roots of the centrals, slightly longer, and more gradually tapering toward the apex. The pulp-cavities of all the incisors have the same shape—like that of an elongated tube. The enamel is thicker before than behind, and thinnest at the sides.

The function of this class of teeth, as their name imports, is to cut the food, and for the performance of this office they are admirably fitted by their shape. As age advances, their edges often become blunted; but the rapidity with which they are worn away depends altogether upon the manner in which those of the upper and lower jaw come together.

THE CUSPIDATI, OR CUSPIDS.

The *Cuspidati*, *Canini*, or *Cuspids*, so called from the Latin word *cuspis*, "a point," because they terminate in a point, are commonly known by the name of canines (Figs. 46 and 47). They are situated next to the incisors, and occupy the space between the lateral incisor and first bicuspid, two to each jaw, one on either side. They somewhat resemble the upper central incisors with their angles rounded. Their crowns are conical, very convex externally, and their palatal surface more uneven, and they have a larger tubercle than the incisors. The crown ends in a blunt point, and the cutting edge slopes away on each side. The slope toward the bicuspid is the longer, and causes the crown to be asymmetrical. The lingual surface presents a median and two lateral ridges; they converge toward the well-marked cingulum, which is often produced into a distinct cusp (Fig. 48).

The lower canines have not such pronounced features as the upper; the point is blunter, and the median ridge is absent from the lingual surface. They are stronger and generally more durable teeth than the incisors, and their roots form a vertical ridge on the external surface of the alveolar process. Their roots are also larger, and of all the teeth the longest; like the incisors, they are also single, but have a groove extending from the neck to the extremity, showing a step toward the formation of two roots. A cuspid, like an incisor, has four surfaces and four angles, designated by the names already given—labial, palatal or lingual, mesial, distal.

FIG. 48.

The breadth of the crown of an upper cuspid is about four lines, that of a lower is about three and a half; but, as in the case of the incisors, the width of the crowns of these teeth is variable. The length of a cuspid is greater than that of any other tooth in the dental series—it being about thirteen lines. The breadth of the neck of one of these teeth is about one-third greater in front than behind, and from before backward it measures about four lines.

The upper cuspids, with no good reason, are sometimes called eye teeth; the lower are termed stomach teeth.

The inferior cuspids have a shorter root than the superior cuspids, and the median cusp is not so pointed.

These teeth are for tearing the food, and in some of the carnivorous animals, where they are very large, they not only rend but also hold their prey.

The incisors and cuspids together are termed the *oral* teeth.

THE BICUSPIDS.

The *Bicuspids*, so called from the Latin words *bis*, "twice," and *cuspis*, "a point" (Figs. 46 and 47), four to each jaw and two on either side, are next in order to the cuspids. They have two distinct prominences or cusps on their grinding surfaces, one external and the other internal, and separated by a deep depression or notch. In the superior bicuspids the external cusp is somewhat larger than the internal cusp, while in the inferior bicuspids the internal cusp is larger than the external, and the root is more cylindrical in form. They are also named premolars or the small molars, but are more commonly designated as the first and second bicuspids. They are thicker from their buccal to their palatine surface than either of the incisors, and are flatter on their sides. The buccal surfaces are very convex, and the crowns of the second bicuspids are generally somewhat larger than those of the first bicuspids, and more of a square form.

A bicuspid has five surfaces: namely, two *proximate — mesial* and *distal;* one *buccal;* one *palatal* or *lingual* surface, as the tooth may be in the upper and lower jaw, and one *grinding* surface. It has four angles; one *anterior* or *mesio-* and one *posterior* or *disto-palato-proximate* and one *anterior* or *mesio-* and one *posterior*, or *disto-bucco-proximate* angle.

The size of these teeth, like that of the incisors and cuspids, is variable. The buccal surface of the crown of a superior bicuspid of ordinary size at its broadest part is about three lines in breadth, while the anterior and posterior proximal surfaces are about four lines. The palatal is quite as wide as the buccal surface. All the diameters of the crown of a lower bicuspid are usually a little less than those of an upper. The entire length of a bicuspid is ordinarily about eleven lines.

The superior bicuspids have generally two roots, but sometimes a single root, which is often deeply grooved, while the inferior bicuspids have but one root. The deeply-grooved root is indicative of two pulp-cavities, which may unite at the central portion of the root and form a narrow transverse fissure at the neck of the tooth. Of the two roots of the superior bicuspids, the inner or palatal is smaller than the outer or buccal, each root having an opening for the vessels and nerves to enter.

THE MOLARS.

The *Molars*, so called from the Latin word *molaris*, "grinding," and designated as first, second, and third molars (Figs. 49 and 50), occupy the posterior part of the alveolar arch, and are six in each jaw, three on either side. The first, owing to the period of their eruption,

are called the sixth-year molars, and the second, for the same reason, are called the twelfth-year molars, while the third are called the dentes sapientiæ, or wisdom teeth, from the Latin word *dens*, "a tooth," and *sapientia*, "wisdom," being erupted at a period when maturity is reached. The molars are distinguished by their greater size—the first and second being the largest; the grinding surfaces have the enamel thicker, and are surmounted by four or five tubercles or cusps, with as many corresponding depressions arranged in such a manner that the tubercles of the upper jaw are adapted to the depressions of the lower, and *vice versa*.

A molar, like a bicuspid, has also five surfaces and five angles, designated by the names already given to similar surfaces on the bicuspids.

The upper molars have three roots, sometimes four, and as many as

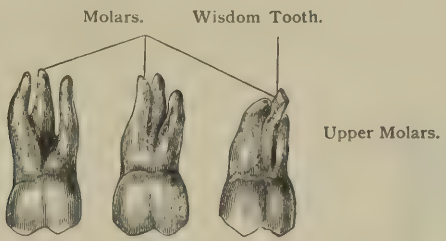

FIG. 49.

FIG. 50.

five are occasionally seen; of these roots two are situated externally, almost parallel with each other, and perpendicular; the third root forms an acute angle, and looks toward the roof of the mouth. The former are called the *buccal* roots, and the latter the *palatal*. The roots of the first two superior molars correspond with the floor of the maxillary sinus, and sometimes protrude into this cavity, their divergence securing them more firmly in their sockets. The lower molars have but two roots—the one anterior, the other posterior; they are nearly vertical, parallel with each other, and much flattened laterally.

The last molar, or wisdom tooth, is both shorter and smaller than the others; the roots of the upper wisdom tooth are, occasionally,

united so as to form but one ; while the last molar of the lower jaw is generally single and of a conical form.

The roots of the molar teeth, both of the upper and lower jaw, after diverging, sometimes approach each other (converge), embracing the intervening bony partition in such a manner as to constitute an obstacle to their extraction.

The bucco-palatal diameter of the crown of an upper molar is usually a little less than the antero-posterior. In the lower jaw, the bucco-lingual and antero-posterior diameters are generally about the same.

The crown of the first molar is generally larger than the second, and the second larger than the third or wisdom tooth ; and the crown of the last-named tooth is always smaller in the upper than in the lower jaw.

The pulp-cavities correspond to the external form of the roots, and at the necks of these teeth they unite into a common cavity called the pulp-chamber, which often ends in cornua corresponding to the cusps (Fig. 51).

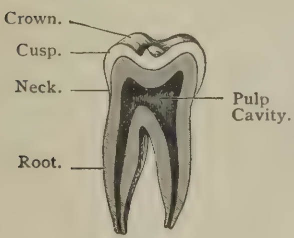

FIG. 51.

The length of a molar tooth varies from eight to twelve and a half or thirteen lines.

The molars and bicuspids together constitute what are termed the buccal teeth.

The use of the molars, as their name signifies, is to triturate or grind the food during mastication, and for this purpose they are admirably adapted by their mechanical arrangement.

ATTACHMENT OF THE TEETH.

The manner in which the teeth are confined in their sockets is by a union called *gomphosis*, from the resemblance of this kind of articulation to the way in which a nail is received into a board. The teeth having but one root, and those with two perpendicular roots, depend greatly, for the strength of their articulation, on their nice adaptation to their sockets.

Those having three or four roots have their firmness much increased by their divergence ; also teeth with two roots which converge.

But there are other bonds of union ; by the periosteum lining the alveolar cavities, and investing the roots of the teeth ; also by the blood-vessels entering the apices of the roots ; and finally, by the gums, which will be noticed in another place.

DIFFERENCES BETWEEN THE TEMPORARY AND PERMANENT TEETH.

The temporary and permanent teeth differ in several respects, and on this point I will give Mr. Bell's observations :—

"The temporary teeth are, generally speaking, much smaller than the permanent ; of a less firm and solid texture, and their characteristic forms and prominences much less strongly marked. The incisors and cuspids of the lower jaw are of the same general form as in the adult, though much smaller ; the edges are more rounded, and they are not much more than half the length of the latter. The molars of the child, on the contrary, are considerably larger than the bicuspids which succeed them, and resemble very nearly the permanent molars.

"The roots of the tooth in the molars of the child are similar in number to those of the adult molars, but they are flatter and thinner in proportion, more hollowed on their inner surfaces, and diverge from the neck at a more abrupt angle, forming a sort of arch."

In the temporary teeth the union of the enamel and cementum is distinctly marked by a well-defined ridge of enamel at the base of the crown, which forms a constricted neck ; whereas in the permanent teeth the union of the enamel and cementum at the base of the crown is very indistinct.

RELATIONS OF THE TEETH OF THE UPPER TO THOSE OF THE LOWER JAW, WHEN THE MOUTH IS CLOSED (ARTICULATION).

The crowns of the teeth of the upper jaw are generally arranged in the form of a semi-ellipse, and describe a rather larger arch than those of the lower. The upper incisors and cuspids naturally shut over and in front of the lower ; but sometimes they fall plumb upon them, and at other times, though unnaturally, they come on the inside. In the curve of the arch, the cuspids stand a little prominent, giving a fullness to the angles of the mouth. The external tubercles or cusps of the superior bicuspids and molars generally strike on the outside of those of the corresponding inferior teeth. By this beautiful adaptation of the tubercles of the teeth of one jaw to the depressions of those of the other, every part of the grinding surface of these organs is brought into immediate contact in the act of mastication ; which operation of the teeth, in consequence, is rendered more perfect than it would be if the organs came together in any other manner.

The incisors and cuspids of the upper jaw are broader than the corresponding teeth in the lower ; in consequence of this difference in the lateral diameter of the teeth of the two jaws, the central incisors of the upper cover the centrals and about half of the laterals in the lower, while the superior laterals cover the remaining half of the infe-

rior and the anterior half of the adjoining cuspids. Continuing this peculiar relationship, the upper cuspids close over the remaining half of the lower and the anterior half of the first inferior bicuspids, while the first superior bicuspids cover the remaining half of the first inferior and the anterior half of the second. In like manner, the second bicuspids of the upper jaw close over the posterior half of the second and the anterior third of the first molars in the lower. The first superior molars cover the remaining two-thirds of the first inferior and the anterior third of the second, while the two-thirds of this last and anterior

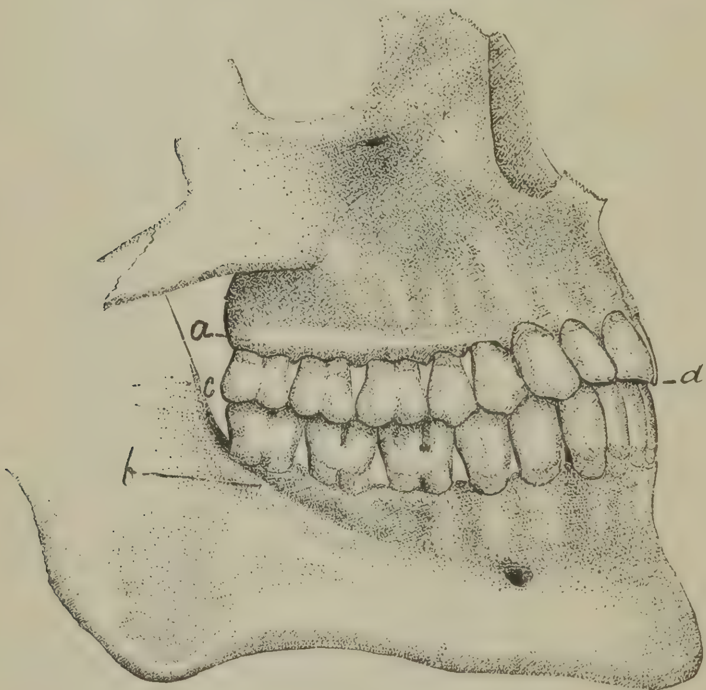

FIG. 52.

third of the lower dentes sapientiæ are covered by the second upper molars. The dentes sapientiæ of the superior maxilla, being usually about one-third less in their antero-posterior diameter, cover the remaining two-thirds of the corresponding teeth in the lower jaw. (See Fig. 52.)

Thus, from this arrangement of the teeth, it will be seen that when the mouth is closed each tooth is opposed to two; and hence, in biting hard substances and in mastication, by extending this mutual aid, a power of resistance is given to these organs which they would not

otherwise possess. Moreover, as Mr. Tomes very justly observes, if one, or even two adjoining teeth should be lost, the corresponding teeth in the other jaw would, to some extent, still act against the contiguous organs, and thus, in some degree, counteract a process, which nature sometimes sets up for the expulsion of such teeth as have lost their antagonists.

CHAPTER X.

MALFORMED TEETH.

Peculiarities in the Formation and Growth of the Teeth.—In the development and growth of the various parts of the body, curious and interesting anomalies are sometimes observed; but in no portion of it are they more frequent in their occurrence or diversified in their char-

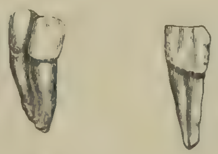

FIG. 53. FIG. 54.

FIG. 53 shows the front view of the lateral incisor and canine from the left side of the under jaw, united throughout their entire length, but with the line of junction well marked. The age at which they were removed was seven years. The corresponding teeth on the opposite side of the jaw were similarly united.

FIG. 54 shows the representation of the lateral incisor and canine from the left side of the lower jaw of a patient aged nine years. In this example the line of junction is less distinctly marked than in the preceding illustration, and is altogether wanting near the base of the enamel.

acter than in the teeth. But aberrations in the formation and growth of these organs are, for the most part, confined to the teeth of second dentition.

Although the deciduous teeth are much more exempt from deviation in form, size, and number than the permanent teeth, yet they are not altogether free from such irregularities. One form of irregularity of these teeth may consist in a greater number than twenty; while in other cases there may be a numerical deficiency. Deciduous teeth, especially the molars, are occasionally met with having more than the normal number of roots. A more common form of irregularity is the union of two, or sometimes even three, deciduous teeth, generally incisors, or an incisor and a canine, either by a union in the cementum, or in the dentine and enamel (Figs. 53 and 54). When the union is in the cementum, the roots only are united, but where it

is in the dentine and enamel there is a fusion of both the crowns and the roots, and one pulp common to the two teeth (geminous).

Fig. 55[1] represents two specimens of triple fusion of the deciduous right superior lateral incisor and cuspid, with a supernumerary tooth between the two, taken from the mouth of a boy three years of age. Fig. 55[2] represents another specimen of triple fusion of deciduous teeth from the mouth of a little girl, which occupied the same position as that represented by Fig. 55[1], and was composed of the same teeth. Both of these specimens were extracted by Dr. Isaac Douglass.

Malformed Permanent Teeth.—Irregularity in the forms of permanent teeth is much more common than is the case with deciduous teeth; some of the former differing so much in size, either above or below what is normal, as to occasion disfigurement; in the same mouth very large teeth may be associated with others extremely small, or the malformation may be confined to a single tooth of the set. But examples of this kind are not very frequent; for where there is an

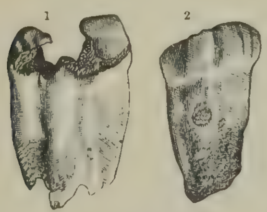

Fig. 55.

Fig. 56.

Fig. 57.

increase or diminution in the size of the teeth of one class, there is generally a corresponding change in that of the other.

Aberrations of this character are probably dependent upon some diathesis of the general system, whereby the teeth, during the earlier stages of their formation, are supplied with an excessive or diminished quantity of nutriment. Again, the malformation may be confined to the root, while the crown of the tooth is of the normal size.

A superior central incisor may have a root which is abnormally small, while the crown is of the usual size.

Another malformation consists in an excess of the normal number of roots, the superior molars sometimes having four or six slender roots, and the inferior molars three and four, the inferior canines two, and the superior bicuspids three roots. (Figs. 56, 57.) The variations in form of the permanent teeth are beyond enumeration; in some cases teeth with single roots are bent at different angles. The crowns of the teeth, also, frequently present deviations from the natural shape equally striking and remarkable.

Figs. 58, 59, and 60 represent molar and incisor teeth with malformed roots.

Teeth with flexed roots are also met with. Figs. 61 and 62 represent superior central incisors with single and double flexions of the roots.

Mr. Fox gives a drawing of a tooth very much resembling the letter S. The author has also met with several examples of teeth similarly deformed, and from like causes.

Some very remarkable deviations have been known to take place in the growth of the teeth. The most singular case on record is that related by Albinus. "Two teeth," says he, "between the nose and the orbits of the eye, one on the right side and the other on the left, were inclosed in the roots of those processes that extend from the maxillary

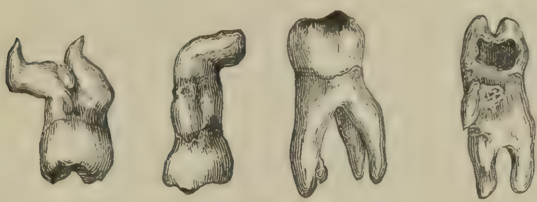

Fig. 58.

Fig. 59.

Fig. 60.

Fig. 61.

Fig. 62.

bones to the eminence of the nose. They were large, remarkably thick, and so very like the canines that they seemed to be these teeth, which had not before appeared; but the canines themselves were also present, more than usually small and short, and placed in their proper sockets. The former, therefore, appear to have been new canines, which had not penetrated their sockets, because they were situated where these same teeth are usually observed to be in children. But what is still more remarkable, their points were directed toward the eyes, as if they were the new eye teeth inverted. And they were also so formed that they were, contrary to what usually happens, convex on the posterior and concave on the anterior." A case of a somewhat similar character is mentioned by Mr. John Hunter.

The following case is in the words of Mr. G. Wait: "While I was

prosecuting my anatomical studies, I was struck with the appearance of a cuspid of the upper jaw ; it was short, and appeared as if the body of the tooth was in the jaw, and that it was the tip of the root that presented itself. Upon further examination I found this verified, and after the cranium and lower jaw were properly macerated and cleansed, I found one of the lower bicuspids in the same position."

The following is one of the several cases of deviation in the growth of the teeth that have come under the author's observation : In 1840, he was requested to extract a tooth for a lady of Baltimore under the following circumstances. She had, for a time, experienced a great deal of pain in her upper jaw, and supposed it to originate from the second molar of the right side, but which was perfectly sound. Meanwhile her general health became impaired, and her attending physician, thinking that the local irritation might have contributed to her debility, advised the extraction of the tooth. On removing it, the cause of the pain at once became apparent. The dens sapientiæ, which had not hitherto appeared, was discovered with its roots extending back to the utmost verge of the angle of the jaw, while its grinding surface had been in contact with the posterior surface of the crown and neck of the tooth just extracted. On the removal of the wisdom tooth the pain ceased.

About the middle of December, 1849, a youth aged sixteen applied to the author to extract a right superior bicuspid, which, he said, was ulcerated at the root. On examining his mouth, he discovered only one bicuspid, but above and between the root of this and that of the first molar, he observed a small fistulous opening. On introducing a small probe, it immediately came in contact with the crown of a tooth looking toward the malar process of the superior maxillary, which, on extraction, proved to be the second bicuspid.

The author has in his possession several molar and bicuspid teeth which have small nodes upon their necks, covered with enamel ; and there are jaws in the Museums of the Baltimore Dental Colleges which have a number of teeth presenting this anomaly.

The author has two teeth in his possession of most singular shape, presented to him by his brother, the late Dr. John Harris. They were extracted in July, 1822, from the right side of the upper jaw of a young gentleman, nineteen years of age, by the name of Crawford. They occupied the place of the first and second bicuspids and their crowns are almost wholly imbedded in lamellated dentine, that should have constituted their roots, but which are entirely wanting. Judging from their appearance, one would be inclined to suppose that, their sacs failing to contract, they remained stationary in their sockets, and as the base of the pulps elongated, they came in contact with the

bottom of the alveoli, and were caused to bulge out and to be reflected upon their crowns, to the enamel of which, nearly to their grinding surfaces, they are perfectly united. For some time previously to the extraction of these teeth, they had been productive of considerable irritation and pain in the gums and jaw, and it was for the relief of the suffering which their presence induced that they were removed.

Since the above was written, the author has seen a still more remarkable deviation in the growth of a tooth. It is in the upper jaw of an adult skull in which the natural teeth are all well formed and regularly arranged in the alveolar border, but between the extremities of the roots of the superior central incisors, in the substance of the jaw, there is a supernumerary tooth the crown of which looks upward toward the crest of the nasal plates of the two bones. The whole tooth is about one inch in length, and the apex of the crown is nearly on a level with the floor of the nasal cavities. There is also in the Dental Museum of the University of Maryland a central incisor of the upper jaw, with the root bent upon, and in contact with, the labial surface of the crown (Fig. 63).

FIG. 63.

United Teeth.—Inclosed as each tooth is in a distinct sac, and separated on either side by a bony partition from the adjoining teeth, until after the completion of the formation of the enamel, it may be difficult to conceive how osseous union could take place between two of these organs, but so many examples of such union are met with, that there is no longer any question concerning its possibility.

Two or more teeth, generally the molars, may be permanently joined together by a union in the cementum of their roots, occasioned by diseased action, such as exostosis, taking place after the complete development of the teeth. The term "osseous union" has been applied to such cases.

Fig. 64 represents united second and third molars, the one figure presenting the buccal aspect, and the other the palatal.

Fig. 65 also represents the osseous union of superior second and third molars.

Many years ago we had an opportunity of seeing two interesting cases. One consisted in the union of the crowns of the central incisors of the upper jaw, the palatine surface of which presented the appearance of one broad tooth, while anteriorly they had the semblance of two teeth; the other case consisted in the union of the right central and lateral incisors of the lower jaw.

A professional friend informed the author, in a conversation some years since, that he had met with a case of osseous union between a

second bicuspid and the first molar of the lower jaw, which was so palpable that there could have been no doubt of its existence.

Cases of this nature are not very common, and a connection of the roots of two teeth, by an intervening portion of the alveolus, is very easily mistaken for osseous union of the roots themselves. A few years since, in extracting a second molar of the upper jaw, the author brought the dens sapientiæ along with it. At first he thought there was osseous union of the roots, but upon close examination found a very thin portion of the alveolar wall between, to which their roots were firmly attached. Such a case as this would, in many instances, be set down as an example of osseous union.

An osseous union of the teeth is, fortunately, of rare occurrence; if it were otherwise, it would be productive of many accidents in the extraction of teeth. Apart from this consideration, it can be of but little importance either to the practitioner or to the physiologist.

FIG. 64.

FIG. 65.

Since the publication of the first edition of this work, a number of cases of osseous union of the teeth have fallen under the observation of the author. Among them are a number of examples of osseous union of the temporary teeth.

Geminous or Fused Teeth.—When two teeth are united by a union in the enamel and dentine throughout the entire length of their crowns and roots, they are termed "geminous" or "fused" teeth, as the malformation is occasioned by a fusion of their pulp, from close proximity and pressure, one pulp being common to the two teeth. The two central incisors and the lateral incisors and canines are more commonly joined together in this manner than any of the other teeth. Fig. 66 represents geminous central and lateral incisors, showing the labial and palatal aspects, these specimens being in the Dental Museum of the University of Maryland.

Other cases occur where the union or fusion is confined to the crowns of the teeth, the roots being separate.

Fig. 67 represents two geminous central incisors, the crowns of which are united while the roots are separate.

Supernumerary Teeth.—The development of supernumerary teeth is usually confined to the anterior part of the mouth, and more frequently to the upper than to the lower jaw. They sometimes, however, appear as far back as the dentes sapientiæ, and Hudson says he has seen them behind these teeth. We have now in our anatomical collection two supernumerary teeth that were extracted, one from behind and the other at the side of one of the upper wisdom teeth.*

The crowns of supernumerary teeth which appear in the anterior part of the mouth are usually of a conical shape, and for the most part situated between the central incisors; they usually have short, knotty roots; sometimes, however, they bear so strong a resemblance to the other teeth that it is difficult to distinguish the one from the other. We once saw two lateral incisors in the lower jaw, both of

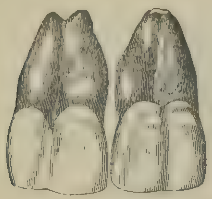

FIG. 66.

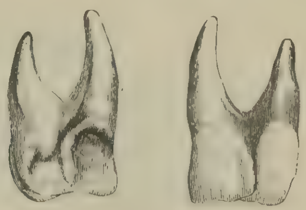

FIG. 67.

which were so well arranged and perfectly formed that it was impossible to determine which of the two ought to be considered as the supernumerary. Mr. Bell mentions a case in which there were five lower incisors, all of which were well formed and regularly arranged. Such teeth, however, are more properly known as "supplemental."

Supernumerary cuspids rarely if ever occur, but supernumerary bicuspids are occasionally met with. Delabarre says he has seen them; and we have met with three examples of the sort; in each of these instances the teeth were very small, not being more than one-fourth as large as the natural bicuspids, with oval crowns, and placed partly on the outside of the circle and partly between the bicuspids. We extracted one of them, and have it still in our possession. Its root is short, round, and nearly as thick at its extremity as it is at the neck of the tooth.

The supernumerary teeth that appear further back than the bicuspids, though much smaller, bear a strong resemblance to the dentes sapientiæ.

* These teeth were removed by Dr. Chewning, dentist, of Fredericksburg, Va.

Supernumerary teeth, although generally imperfect in their formation, are less liable than other teeth to decay. This may be attributable to the fact that they are harder, and, consequently, not so susceptible to the action of the causes that produce the disease.

Although the occurrence of supernumerary teeth rarely disturbs the arrangement of the others, their presence is sometimes productive of the worst form of irregularity (Fig. 68 represents a case of this kind); and even when they do not have this effect, they impair the beauty of the mouth, and, for this reason, should be extracted as soon as their crowns have completely emerged from the gums.

To the practitioner of dental surgery, the occurrence of supernumerary teeth is interesting only in so far as it affects the beauty of the mouth and the relationship which the teeth of the upper jaw sustain to those of the lower; but to the physiologist it involves the question, what determines their development? In propounding this interroga-

FIG. 68.

tory, however, it is not our intention to enter upon its discussion in this place. (See "Origin of Permanent Teeth.")

Supplemental Teeth.—The term supplemental is employed to designate teeth which resemble in shape and size those of the regular series, as a third lateral incisor or canine, or a fifth bicuspid, in either the upper or lower jaw, the additional teeth being perfectly normal in form. Such teeth are extremely rare, but we have met with several examples in which supplemental teeth so closely resembled the natural incisors that no difference could be discerned between them. We have also met with three superior lateral incisors where it was impossible to determine which was the supplemental tooth.

Nodular Teeth.—Occasionally teeth are found having small, white, pearly nodules on their necks, or upon the roots near the termination of the enamel. These enamel nodules consist of a thick layer of enamel covering a cone of dentine, which projects from the neck or root of the tooth, and contains dentinal tubuli. They are similar to the excrescences in the form of extra cusps, which are sometimes found on the crowns of the teeth, especially the molars, and the enamel cov-

ering them is formed by a true enamel organ. These nodules are of physiological interest only, as they do not give rise to any pathological symptoms. They are a variety of dental exostosis which is extremely rare and difficult to account for. Sometimes they may be mistaken for supernumerary teeth, and an attempt to remove them may result in the extraction of the tooth to which they are attached.

Figs. 69 and 70 represent permanent teeth with nodules of enamel attached to the necks and sides of the roots.

Odontomes.—This term has been generally applied to tooth tumors developed from the hard tissues of the teeth, but it is now restricted to those irregular masses of dentinal tissues which result from some hypertrophied condition of the tooth papilla or formative pulp. In such cases the irregular mass consists of dentine and enamel, bearing little or no resemblance to a tooth; and it originates after the commencement of calcification.

Fig. 71 represents an odontome consisting of an irregular mass of tooth tissues.

FIG. 69.

FIG. 70.

FIG. 71.
a. Smooth enamel-coated surface. *b*. Nodules of enamel.

The teeth described by Salter, Wedl, and others, under the name of "*Warty Teeth*," and which are composed of tissues hypertrophied and folded together into an irregular and complicated mass, afford a fair example of odontomes.

It is not unusual for odontomes to remain in the mouth for a considerable time without causing trouble, but sooner or later they may give rise to inflammation followed by suppuration in the adjoining parts, when their immediate removal is necessary. Mr. John Tomes refers to a case where the body of the sphenoid bone was found to be the seat of a tumor containing dentine.

Figs. 72, 73 represent dental anomalies extracted from the mouth of an old woman seventy years of age, one of the hairy Burmese family, by Dr. J. A. Daly, and are described as follows by Dr. C. T. Caldwell:—

"I find two very remarkable instances of gemination or organic

union of two neighboring teeth. The measurements and outlines of the drawing are as near as possible correct. Figs. 72 and 73.

"The lines A B and C D are intended to show the position of the teeth in the jaw, the portions above A B and below C D indicating the parts exposed above the gum. They were covered by a thick layer of dark-brown concretion, the exact nature of which I have not determined.

"Fig. 72 shows the right second molar and wisdom-tooth of the lower jaw so completely joined together that both crowns and roots are united throughout their entire length. The two roots of the second molar may be easily made out in the specimen, and just behind them, and completely fused with them, is the connate root of the wisdom-tooth.

"Still more remarkable than this is the specimen represented by Fig. 73, wherein the union of two upper molars is confined to the roots, which are so welded or blended together as to leave but little trace of the several roots. This specimen was at first supposed to be a large-sized molar

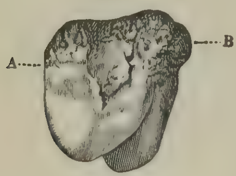

Fig. 72.

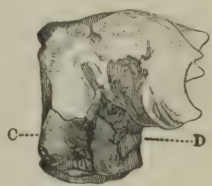

Fig. 73.

with an enormous exostosis, but a section through the parts shown in the drawing disclosed a pulp-cavity, and close examination revealed the fact that this portion of the mass is in reality the crown of a tooth, made up of enamel, dentine, and pulp cavity, filled with nerve and nutrient vessels, as in ordinary teeth. The tubercles or cusps, having never been subjected to wear, are in a perfect condition on what should have been the top or free surface of the crown, while the roots had become coalescent with those of its neighbor in such a manner that only one of the united teeth could assume an upright or natural position in the jaw, the other being forced into a horizontal position, with only a side protruding above the surface of the bone.

"This gemination or coalescence of contiguous teeth occurs during an early stage of their development, and is due to absorption of the intervening bony tissue caused by pressure, where, as in this case, several very large teeth crowd themselves into a very small mouth."

Syphilitic Teeth.—Mr. J. Hutchinson was the first to call attention to a class of malformed permanent teeth, the result of inherited syph-

ilis, and he asserts that certain deviations in the forms of teeth are valuable as diagnostic marks of the existence of syphilis of a congenital constitutional type, and he classes them with syphilitic interstitial keratitis. This author describes syphilitic teeth as follows: "In those who had cut their permanent teeth the condition of the incisor teeth was very peculiar, both in form, color, and size. As a diagnostic of hereditary syphilis, various peculiarities are often presented by the others, especially the canines; but the upper central incisors are the test teeth. When first cut, these teeth are short, narrow from side to side at their edges, and very thin. After awhile a crescentic portion from their edge breaks away, leaving a broad, shallow, vertical notch, which is permanent for some years, but between twenty and thirty usually becomes obliterated by the premature wearing down of the teeth. The two teeth often converge, and sometimes they stand widely apart. In certain instances in which the notching is either

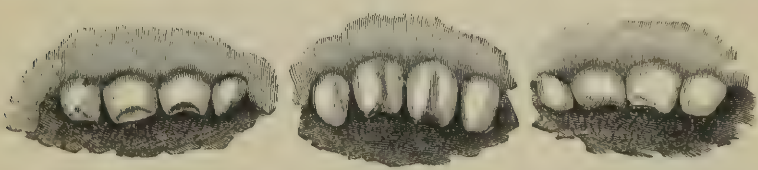

FIG. 74.

FIG. 75.

wholly absent or but slightly marked, there is still a peculiar color and a narrow squareness of form, which are easily recognized by the practiced eye. . . . . . Indeed, there can be no doubt whatever as to the truth of the assertion that malformed upper incisors (permanent set) are all but invariably coincident with this disease."

Henry W. Williams, M. D., Professor of Ophthalmology in Harvard University, confirms Mr. Hutchinson's observations, and says: "The central incisors of the second dentition have a peculiar crescentic notch at their lower margins, and the lateral incisors and canines, as well as the molars, are often small, peg-shaped, and with tuberculated prominences upon their surface. They are, perhaps, also irregularly set in the jaw, and of bad color, or prematurely decayed."

Figs. 74 and 75 represent syphilitic teeth in a boy and two girls, aged respectively twelve, fourteen, and seventeen years.

Mr. John Tomes describes these teeth as being of "a dusky, opaque appearance, and are small relatively to the size of the jaws, so that distinct intervals are left between them; moreover, they are of a very soft character, so that they speedily become worn down, and the characteristic transverse notch obliterated." Mr. Hutchinson remarks: "Inasmuch as specific inflammations do not occur during the period of intra-uterine life, the teeth belonging to the deciduous series are not liable to be affected, though they may be lost by exfoliation consequent on stomatitis and periostitis. On the other hand, the occurrence of specific affections of the mouth soon after birth may be readily supposed to affect the permanent teeth which are at this time developing, and certain characters are enumerated as indicative of such interference with the growing teeth."

Deviations of the teeth from the normal condition are so numerous and varied in their character, that it would be impossible to describe all of them.

Under the title of "*dilaceration*," Mr. John Tomes describes a condition of tooth resulting from displacement of the calcified portion of a tooth from the tissues which were instrumental in its production, the development being continued after the normal position of the calcified portion was lost; for example, the crown of an incisor when partly formed may move from its position upon the pulp, and be turned outward or inward, or to either side, and there remain in a state of rest, the development of the tooth continuing with the displacement of one-half of the crown permanently preserved.

FIG. 76.

Fig. 76 represents three cases of dilaceration, two incisors and a bicuspid.

Teeth have also been found with the root at the apex expanded into a cup-shaped disc, on the margins of which are several openings or foramina for the entrance of the nerves and vessels. Also teeth with dentine excrescences in the form of nodules growing from the wall of the pulp-chamber. Sometimes these nodules of secondary dentine almost fill the pulp-chamber, while the parenchyma of the pulp is extensively occupied by small granules. Such excrescences frequently cause pain of neuralgic character. The devitalization of the pulp is the only treatment.

Dilated roots of teeth are caused by the dentinal pulp becoming hypertrophied into a globular structure of considerable size, and when calcified forming an osseous mass, often larger than the tooth itself. Such tumors are composed of an outer layer of cementum,

and a thin shell of dentine enclosing a voluminous pulp, which may or may not be calcified. Dilated roots of teeth may occasion pain when the jaws are opened, with expansion of the jaw at the alveolar portion.

Malformed teeth also result from interrupted development of the dental tissues, which is manifested by the crowns being irregularly grooved or pitted and smaller than the natural size. The incisors are generally thin and atrophied, and the cusps of the canines and molars sharp-pointed, such teeth being deficient in quantity and quality of their tissues, and of a yellow, opaque color. Malformed teeth are sometimes, though rarely, met with where the roots are perfectly developed, while the crowns present a peculiar deficiency, and consist of rudimentary formations which appear like small irregular masses of dentine without any enamel covering. These crownless teeth, as they may be styled, are sometimes found worn level with the gum line.

Another anomaly of tooth-structure, and one that is also very rare, consists of teeth with crowns flattened in an antero-posterior direction, the jaws presenting an edentulous appearance. The sulci of such teeth are misshapen, and the cusps are like narrow ridges.

Exostosed teeth are also included in those that deviate from the normal form, one of the most remarkable instances of which was a case exhibited by Mr. Tomes—a molar of the upper jaw, removed from a patient aged forty-one, who had long suffered pain in the jaw, from which a fistulous passage led through the cheek. Fig. 77 represents this case. (See "Exostosis of the Teeth.")

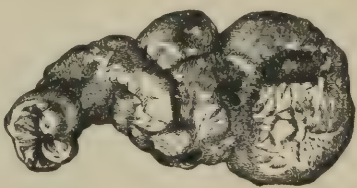

FIG. 77.

Unerupted or Impacted Teeth are often malformed, and may cause dentigerous cysts. (See "Dentigerous Cysts.")

Organic Defects of Structure.—Malformation of teeth caused by organic disease, or disease of tooth-structure, is less frequent in its occurrence than any other disease to which these organs are liable; but as the progress of the affection usually terminates with the action of the causes concerned in its production, it has scarcely been deemed of sufficient importance to merit serious consideration. Hence its etiology and pathology have not been very carefully investigated.

Fig. 78 represents superior and inferior front teeth with crowns disfigured by irregular grooves and pits.

This affection consists in a congenital defect of structure in teeth rather than in the wasting, for want of nourishment, of any of the dental tissues. The congenital form of the disease is evidently the

result of altered function in a portion of one or more of the formative organs—if not of absolute degeneration, from vicious nutrition.

Teeth presenting these organic structural defects may very properly be divided into three varieties. Each has characteristic peculiarities which distinguish it from either of the others. Two are always congenital, and the other, although most frequently congenital, sometimes occurs subsequently to the eruption of the tooth.

First Variety.—The peculiarities that distinguish this variety from either of the others are, that it never impairs the uniformity and smoothness of the surface of the enamel, and is characterized by one or more white, or dark, or light brown, irregularly shaped spots, upon the labial or buccal surface of the tooth. It occurs oftener than the

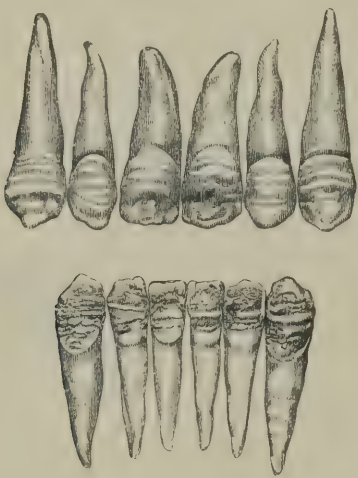

FIG. 78.

third variety, and less frequently than the second. It rarely appears on more than one or two teeth in the same mouth, though several are sometimes marked by it. It is seen on the molars more frequently than the bicuspids, and much oftener on the incisors of the upper jaw than any of the other teeth. We do not recollect to have ever observed it on the cuspids of either jaw, nor on the palatine or lingual surfaces of the incisors.

The enamel is much softer on the affected than on the unaffected parts of the teeth, and may be easily broken and reduced to powder with a steel instrument. It seems to be almost wholly deprived, in these places, of its animal constituents, and to have lost its connection with the subjacent dentine. The size of the defective spots is

almost as variable as their shape, but the most harm resulting from them is the unsightly aspect they sometimes give to the tooth.

Second Variety.—This may be very properly denominated *perforating* or *pitting* defect; it gives to the enamel an indented or pitted appearance, the irregular depressions or holes extending transversely across and around the tooth. The pits are sometimes more or less distinctly separated one from another by prominent lines; at other times they are confluent, and form an irregular horizontal groove. Sometimes they penetrate but a short distance into the enamel; at other times they extend entirely through it to the dentine. Their surface, though generally irregular, usually presents a glossy and polished appearance—a peculiarity which always distinguishes this variety of the affection from erosion. The pits often have a dark-brownish appearance, though sometimes they have the same color as the enamel on other parts of the teeth.

This variety is never confined to a single tooth. Two, four, six, or more corresponding teeth are always affected at the same time in each jaw; and the corresponding teeth on either side precisely in the same manner and in the same place. When more than two are marked, the distance of the pits from the coronal extremity of the tooth varies, according to the progress made in the formation of the enamel at the time of the operation of the causes concerned in the production of the affection. For example, when the line of pits in the central incisors is situated about two lines from their cutting edges, it will scarcely be one line from the cutting edges of the laterals, and only the points of the cuspids will be marked. When the indentations are nearer the edges of the central incisors, they will be on the edges of the laterals, and the cuspids will have entirely escaped.

Sometimes the teeth are marked with two or three rows of pits, and when this is the case, the patient has had either two or three relapses; or has been attacked two or three times in succession with some disease capable of interrupting the progress of the formation of the enamel.

Although the incisors are more frequently marked with these indentations than any of the other teeth, the cuspids, bicuspids, and even the molars, are sometimes affected with them. When the disease attacks the molars, its effects are generally located on the grinding surface. The permanent teeth are more liable to be attacked than the temporary.

This variety occurs oftener than either of the others, and though it sometimes gives to the teeth a disagreeable and unsightly appearance, it rarely increases their liability to decay.

Third Variety.—In this variety the whole or only a part of the crown of a tooth may be affected; the dentine being often implicated as well as the enamel. The tooth usually has a pale-yellowish color, a

shriveled appearance, and is partially or wholly divested of enamel. Sometimes the crown is not more than one-half or one-third its natural size. Its sensibility is usually much increased, and its susceptibility to pain from external impressions is wonderfully excited by acids. It is also more liable than the other teeth to be attacked by caries. The root of the tooth is sometimes, though rarely, affected, and presents an irregular knotted appearance.

The disease is often confined to a single tooth, but it more frequently shows itself on two corresponding teeth in the same jaw. According to our observation, the bicuspids are more liable to be attacked than any of the other teeth. This variety occurs less frequently than either of the others; and, although it increases the liability of the affected organs to caries, they sometimes escape until the twentieth or thirtieth year of age.

The nature of this affection is such as not to admit of cure. The treatment, therefore, must be preventive rather than curative. All that can be done is to mitigate the severity of such diseases as are supposed to produce it, by the administration of proper remedies. By this means their injurious effects upon the teeth may, perhaps, be partially or wholly counteracted.

In some forms of this affection the teeth may not decay more readily than others, so that the only evil resulting is a disfiguration of the organs; but in others, and especially in the pitted variety, it may be necessary to insert fillings at an early age. When the cutting edges of the incisors only are affected, the diseased part may sometimes be removed without injury to the teeth.

CHAPTER XI.

ORIGIN AND DEVELOPMENT OF THE TEETH.*

Of all the operations of the animal economy, none are more curious or interesting than that which is concerned in the production of the teeth. In obedience to certain developmental laws, established by an all-wise Creator, it is carried on from about the sixth week of intra-uterine existence, with the nicest and most wonderful regularity until

* The study of the "origin and development of the teeth" should begin with the "development of the bones of the head and face" and the "description of the mucous membrane," to which subjects the reader is referred.

completed, and excites in the mind of the physiologist the highest admiration.

From small papillæ, observable at a very early period of fetal life, the teeth are gradually developed, and as they increase in size, the papillæ assume the shape of the crowns of the several classes of teeth they are respectively designed to produce. Having arrived at this stage of their formation, they now begin to dentinify, first upon the cutting edges of the incisors, the apices of the cuspids, bicuspids, and eminences of the molars; from thence the process is continued over the whole surface of their crowns, until they become invested with a complete layer of dentine; and so layer after layer is formed, one within the other, until the process of solidification is completed. Before the appearance of the dentinal germ or papilla, however, or coincident with the development of the latter, the organ for the formation of the enamel of the teeth begins to form, and when this enamel organ, which arises in the form of a cord, has acquired the appearance of a hood or cap, the dentinal papilla is so far developed that its surface is covered with cells (odontoblasts) engaged in the formation of the dentine.

In the meantime, and in anticipation of the loss of the temporary teeth, a second set is forming, and as the teeth of the one series are removed, they are promptly replaced by those of the other. Thus, by a beautiful and most admirable provision of Nature, the first set of teeth, intended to subserve the wants only of childhood, while the jaws are too small for the reception of such as are required for an adult, are removed and replaced by a larger, stronger, and more numerous set.

Commencing the description of the development of the teeth with the condition of the jaws of the embryo at the period of the formation of the organs which compose the "dental follicle," namely, the enamel organ, the dentinal germ or papilla, and the follicular wall or sac, there is at an early period no trace of osseous tissue in the *lower* jaw, the maxillary arch having within its component elements a symmetrical cartilaginous band, which extends its entire length, as far as the frame of the drum of the ear, and which is known as "Meckel's cartilage." This cartilage acts a transitory part only, until osseous tissue is developed, first by calcification, and afterward by ossification, when it disappears. (See Development of the Bones of the Head and Face. Figs. 2, 3, and 4.)

As regards the *upper* jaw, the same period of evolution as that of the lower jaw marks the union of the maxillary germs with the median or inter-maxillary germs, which occurs in the human embryo about the fortieth or forty-fifth day. On the surface or rounded portion of

the two maxillary arches thus formed, and which later constitute the alveolar border or process, a depression or groove, called the "dental groove," appears, which, however, is so completely filled or "heaped up" with a bed of epithelial cells as to form a protuberance or smooth ridge, destitute of any fold or depression whatever.

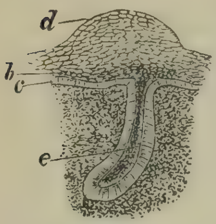

Fig. 79.

d. A mass of epithelium—the "dental ridge." *b.* Younger layer of epithelium. *c.* Deepest layer of epithelium—the prismatic or columnar stratum. *e.* Enamel germ.

This ridge (Fig. 79) is composed of a thick bed of epithelial cells, which, however, on its sides form a coat of a few rows of cells only, and does not include any other well-defined tissue unless it be some vessels, nerves, and muscle-fibres in process of development.

The principal structures of the teeth are derived from such elements as compose the epithelial structure and the tissues beneath which represent the corium and cellular tissue of the mucous membrane, beneath which is the ossifying substance of the jaw—the enamel being formed from the epithelium which fills the dental groove and constitutes the rounded projection or smooth ridge, and the dentine and cementum (crusta petrosa) from the deeper structures of the mucous membrane.

Development of the Enamel.—First, as to the development of the enamel, which is very similar to that of the hair follicle. About the sixth or seventh week of fetal life, the epithelium fills the groove or

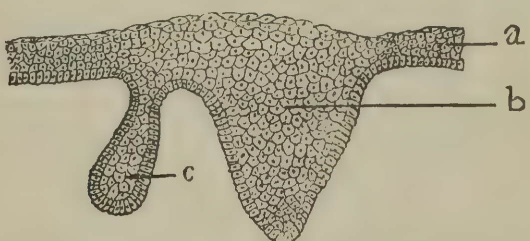

Fig. 80.

a. Flat layer of epithelium. *b.* Proliferation of cuboidal layer, forcing columnar layer downward, producing V-shaped appearance. The removal of these upper layers leaves the "primitive dental groove." *c.* Lamina from which arise the epithelial cords of enamel organs.

depression on the surface of the jaw so full that a small, rounded projection or ridge is formed, from the under surface of which a process sinks into the tissue beneath, the outlines of which resemble in shape the letter V with the apex slightly inclined toward the inner surface (Fig. 80). This epithelial process or band is simply a prolongation of the natural covering of the mouth, which sinks into the embryonic

tissue of the jaw, and forms for itself a groove which it completely fills, and is composed of the same histological elements as the epithelium of the mucous membrane of the mouth.

When this epithelial band is fully formed it presents two surfaces, an external and an internal, and from the latter a process is given off which forms the epithelial lamina. This epithelial lamina is a continuous process extending over the entire epithelial band, being an inflection of the band itself, and its elements are the same, namely, polygonal cells inclosed by a layer of prismatic cells.

The "dental follicle," which, as was before stated, consists of the enamel organ, the dentinal germ or papilla, and the follicular wall, is developed from points on the free extremity of the epithelial lamina. These follicles appear as small tubercles arranged at intervals on the free margin of the lamina, and correspond in number and location to the future deciduous teeth, being the primitive germs of the dental follicles, which retain their connection with the lamina by means of a slender cord, which gradually increases in length as the development of the germ at its extremity progresses. This germ constitutes the enamel organ, while the neck or cord in its progressive lengthening merely serves as a temporary connection with the lamina. This germ presents a spherical form in its early stage (Fig. 81), and is composed of an external layer of prismatic cells (ameloblasts) including a mass of polygonal cells. The younger layer, described as "infant cells," owing to the active cell-multiplication which takes place at the point where the epithelial cord for the tooth is to arise, sinks into the substance of the tissue beneath the epithelium in the form of a pouch. Some contend that the cells of this infant layer are not columnar, but are oval or spheroidal. The enamel organ at about the fourth month of the development of the embryo has undergone very considerable changes, the primitive polygonal cells which compose the central mass or middle region of this organ have been transformed into stellate bodies differing in appearance from the primitive cells, a process, however, which is confined to the cells of the enamel germ, and which does not take place

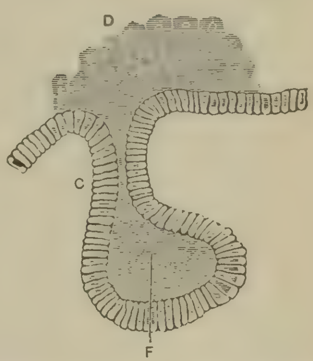

FIG. 81.—PRISMATIC DENTAL FOLLICLE.

c. Prismatic or columnar cells. *d.* Large polygonal cell of the epithelial band. F. Small cells of the epithelial laminæ.

in the cells of the epithelial cord or lamina, thus affording evidence that the constitution of the one differs from that of the other.

These stellate cells (Fig. 82) are composed of a central nucleus surrounded by a transparent or finely granular mass, which mingles with the neighboring elements.

They occupy at first only the center of the enamel organ, and those near the periphery preserve their primitive polygonal form, but become stellate as the organ increases in size, and are formed from the original elements composing the internal mass of the enamel organ, being epithelial in their nature.

After a time the base of these stellate cells presents the regular prismatic form of a hexagon (Fig. 83).

During this modification of the enamel germ, no change appears to take place in the epithelial lamina.

The primitive enamel germ at length loses its original spherical

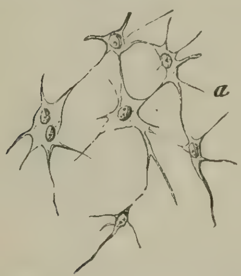

FIG. 82.—STELLATE CELLS OF THE ENAMEL ORGAN. (Diagrammatic, from *Frey*.)

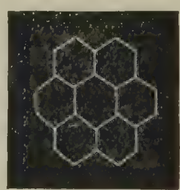

FIG. 83.—REPRESENTS THE HEXAGONAL FORM ASSUMED BY THE BASE OF THE STELLATE CELLS.

form, and becomes somewhat cylindrical, pursuing a horizontal course until it undergoes a considerable increase in length, when, by an abrupt turn, it takes a vertical direction and sinks into the tissues of the jaw.

During such a progress the cord acquires a length in accordance with the requirements of the jaw.

After the epithelial cord has changed its course from a horizontal to a vertical direction, its extremity expands and assumes a club-shape, on account of the multiplication of the polyhedral cells of which its greater portion is composed, and also of the prismatic cells that surround it. This expanded extremity also becomes somewhat spherical, and its upper portion corresponds to the point of connection with the cord, while the lower portion points toward the base of the lower jaw.

This condition represents a fully formed enamel organ, which is the

first trace of the dental follicle. Very soon the lower portion of the enamel organ becomes concave, and assumes the form of a cap or hood, although still retaining its connection with the epithelial cord. At this stage in the development of the enamel organ the dentinal germ or papilla makes its appearance.

During the development of the primitive epithelial cord, lateral germs similar to small rounded nodules, in the form of varicosities,

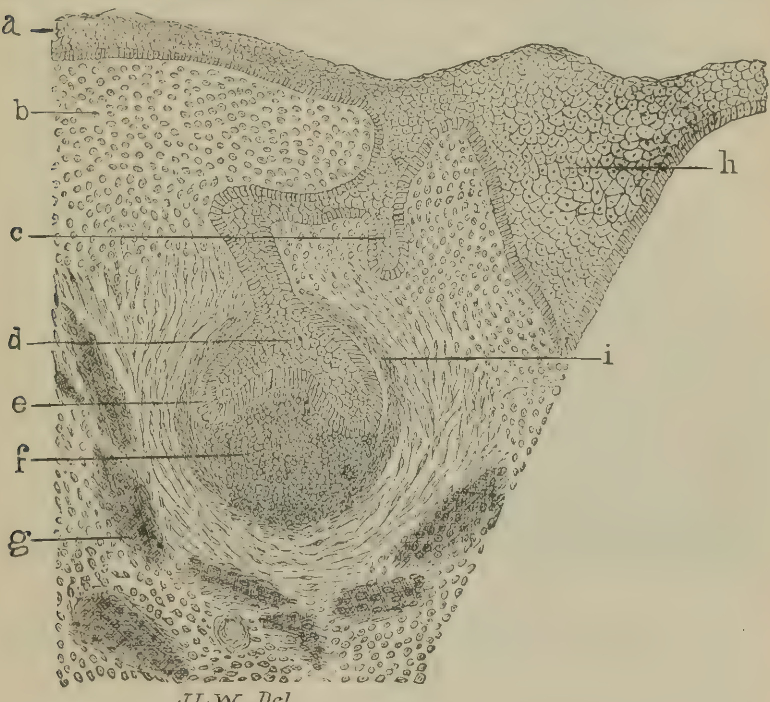

FIG. 84.

a. Epithelial layers of mucous membrane lining mouth. *b*. Embryonal corpuscles of dermal tissue of jaw. *c*. Budding of cord of permanent tooth from cord of temporary tooth. *d*. Enamel organ of temporary tooth. *e*. Columnar or prismatic layer of cells from which ameloblasts or enamel cells are formed. *f*. Dentine germ formed from embryonal corpuscles of dermal tissue. *g*. Commencing ossification of inferior maxilla. *h*. V-shaped band, resulting from proliferation of cells of cuboidal layer. *i*. Development of connective-tissue cells from embryonal corpuscles, forming sac which incloses tooth-germ.

make their appearance, and which, according to Magitot, resemble an irregular chaplet or chain. These lateral germs are composed of small polyhedral cells, like those of the cord itself, with walls formed of a layer of prismatic cells in continuation of the Malpighian layer of the epithelium. From these lateral germs or masses, at a later period, after the cord is ruptured, epithelial prolongations arise.

The primitive cells during the early stage of evolution present the same characteristics on all parts of the periphery, but as soon as the dentinal germ or papilla begins to appear these primitive cells on the concave surface lengthen, while those of the convex surface decrease in size until they disappear entirely, before the atrophy of the enamel pulp; and those of the internal surface remain for the formation of the enamel organ.

Besides increasing in length, the prismatic cells of the concave surface of the enamel organ undergo changes, their extremities, directed toward the center of the enamel organ, forming slender processes, which either unite, or are continuous with filaments from surrounding

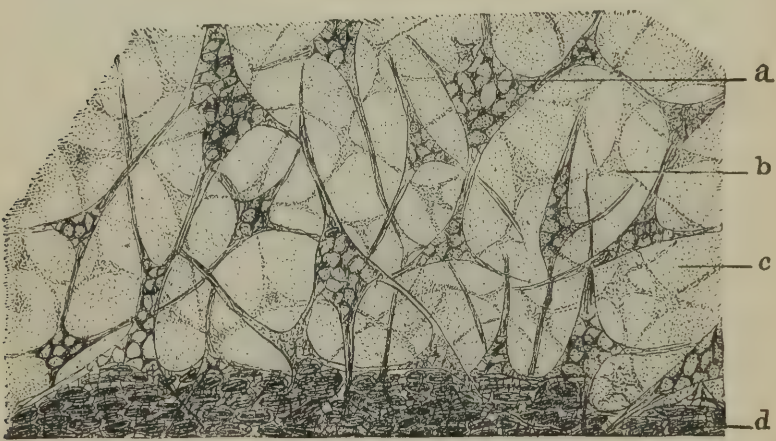

FIG. 85.—ENAMEL ORGAN AND "NASMYTH'S LAYER" OF CELLS, DRAWN UNDER A MAGNIFYING POWER OF 1800 DIAMETERS.

a. Portions of the reticulum which lie exactly in focus; the points of intersection are seen to be made up of a finer and more delicate reticulum. *b*. Parts which lie a little beyond focus. *c*. Granular matter held in the meshes of the reticulum. *d*. "Nasmyth's membrane," or layer of flat cells, just outside of enamel cells.

cells, which constitute the portion of the enamel organ designated as the *stratum intermedium* The stratum intermedium consists of cells which, according to Mr. Tomes, are intermediate in character between those of the bordering epithelium and the stellate reticulum, being branched, but less conspicuously so than the stellate cells with which they are continuous on the one hand, and on the other with the enamel cells. According to Waldeyer, Hertz, and Hannover, since the enamel cells may be frequently seen connected at their lower extremities with the cells of the stratum intermedium, a multiplication of enamel cells from the cells of this stratum, in the direction of their length, may be admitted to occur.

According to Dr. G. V. Black, and quoted by Dr. M. A. Dean, "just before the classification, and even before the odontoblasts make their appearance, the ameloblasts (prismatic cells), and the tissues of the pulp are separated by a well-marked double pellucid layer, which in sections appears as a double band." This double band is represented in Fig. 86 by the two white parallel lines, *A A*, the upper one being the tissue which is identical with the *membrana præformativa* of Huxley, while the lower one represents the *basement membrane* of Ladd and Bowman, and the *membrana præformativa* of Raschkow.

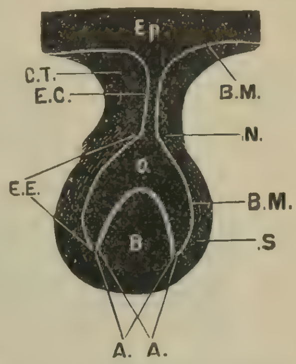

FIG. 86.—*B. M.* Basement membrane. *N.* Neck. *S.* Sac or follicular wall. *O.* Enamel organ. *B.* Bulb. *E. E.* External epithelium of the enamel organ and the basement membrane. *E. C.* Epithelial cord. *C. T.* Connective tissue surrounding the enamel organ. *Ep.* Epidermis or oral epithelium.

The parts embraced between the points where the divergent lines *A. A.* terminate are: (1) The concave face of the enamel organ, lined with a layer of ameloblasts, or the "internal epithelium." (2) The membrana præformativa of Huxley, or the tissue composed of the basal coverings of the ameloblasts. (3) The membrana præformativa of Raschkow, or the basement membrane. (4) The dentine bulb itself. Diagrammatic.

After the epithelial cells are changed into hexagonal prisms, these anastomose and form the hexagonal rods characteristic of fully matured enamel.

The epithelial covering on the outer surface of the enamel remains distinctly perceptible, and after the eruption of the crown of the tooth this layer, which is known as the "dental cuticle"—*cuticula dentis*—and also as "Nasmyth's membrane," may be separated from the enamel surface beneath it by strong acids, when the hexagonal depressions of enamel prisms are apparent, and on the application of nitrate of silver the characteristics of epithelium appear.

Dr. J. L. Williams, in an able article on "embryology," dissents from the opinion of Legros and Magitot concerning the function of the *membrana præformativa* of Raschkow, and positively denies that it has any modifying influence in the process of the development of the teeth; and, while he is not prepared to deny *in toto* the existence of this membrane, says that an examination of many specimens failed to discover this structureless, transparent tissue; and he asks, "How is it possible that the odontoblasts, which are more than $\frac{1}{3000}$ of an inch in diameter, can be developed in a membrane which Beale says is "certainly less than the $\frac{1}{20000}$ of an inch in thickness." Dr. Williams also remarks: "It has been supposed that the so-called ameloblasts, or enamel cells, are formed directly from the layer of columnar or prismatic epithelium which covers the face of the enamel organ." But preceding the development of the enamel cells, the original pris-

matic cells break up or divide into round, nucleated corpuscles, which change is denominated by Professor Heitzmann and Dr. Atkinson a return to an embryonal condition."

"From these embryonal corpuscles are developed the enamel-forming cells, and also an outer layer of smaller cells, from which is formed Nasmyth's membrane."

The same author also regards the enamel organ as a "true secreting

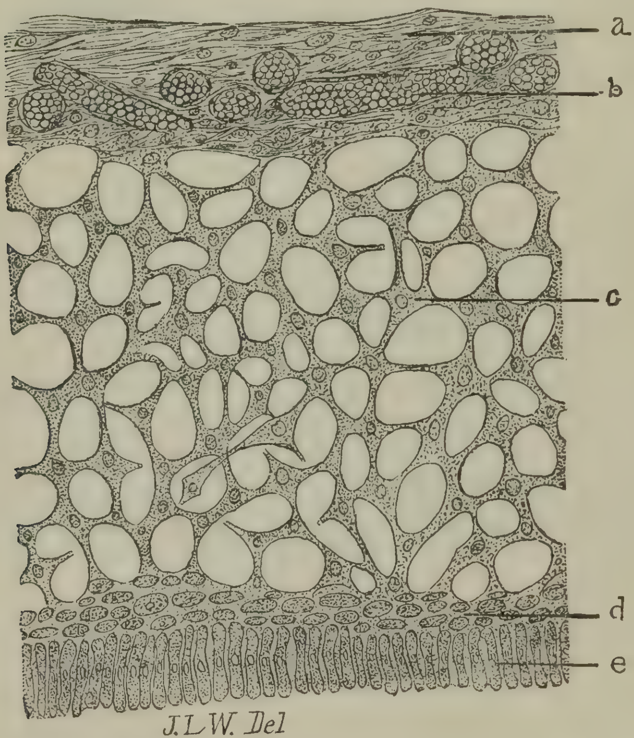

FIG. 87.—*The Specimen from which this drawing was made was placed under a one-tenth inch immersion lens, magnifying about 800 diameters.*

a. Connective tissue of tooth-sac. *b.* Capillary vessels cut transversely and longitudinally, and filled with blood-corpuscles. *c.* Reticulum of enamel organ. *d.* Round and flat layer of cells, forming the so-called "Nasmyth's membrane." *e.* Ameloblasts or enamel cells.

organ," and that the material for the formation of enamel has no other evident source.

Development of the Dentine.—As the epithelium is undergoing this peculiar development into the enamel organ, a projection of the corium of the mucous membrane of the fetal jaw rises up to meet it out of the dental groove. This projection is the dentinal papilla or germ, which is described, after Dursy and Waldeyer, as a ridge, "the

intervening parts of which are atrophied so as to leave papillæ or germs which become coated all over by the enamel organ, and thus the saccular stage of the teeth is produced, the papillæ which are to

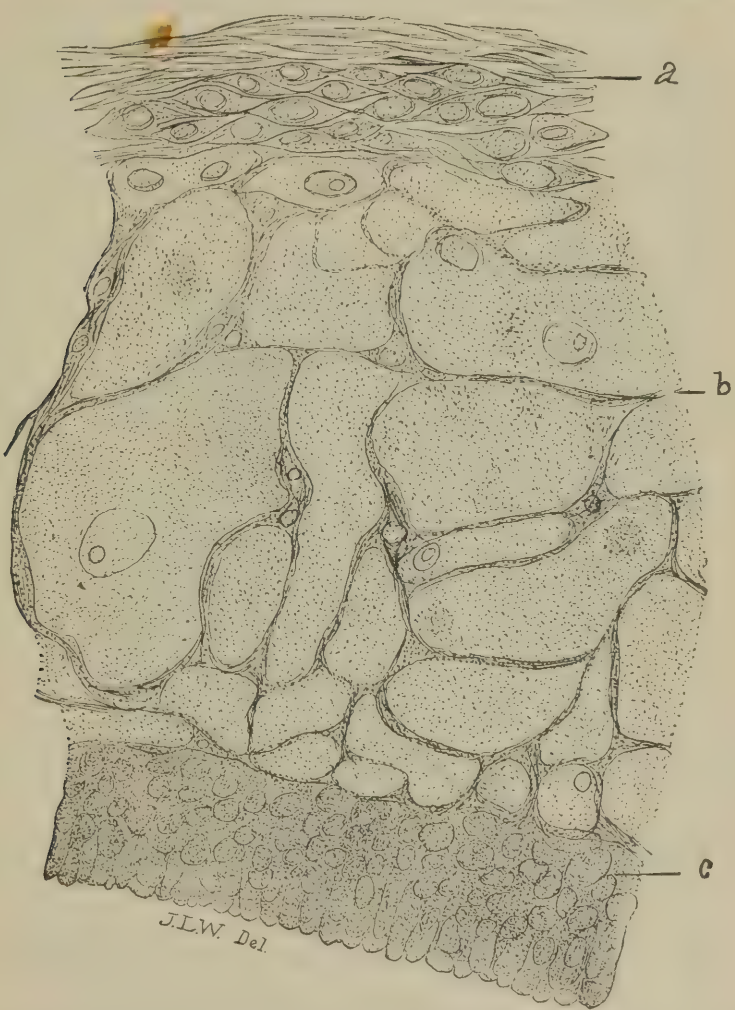

FIG. 88.—*Drawn under the same magnifying power as Fig. 74.*
a. Connective-tissue cells of tooth-sac. *b.* Reticulum of enamel organ. In this drawing it is seen that the reticulum holds in its meshes very large, soft, granular corpuscles, heretofore known as the gelatinous fluid of the enamel organ. *c.* Breaking down of columnar layer of cells into embryonal corpuscles, from which ameloblasts are developed.

form the bulk of the teeth being coated with a vascular connective tissue, isolated by the enamel organ and separated from each other by the growing (osseous) tissue of the fetal jaw."

Dursy, according to Waldeyer, says: "The first germ of the dentine appears in the dental *sacculus*, as a dark semilunar area at the bottom of the dental groove—that is to say, of the enamel germ—coetaneously and continuously with which it is developed along each half of the jaw. At certain points corresponding to the position of the subsequent teeth, the young structure develops in the form of papillæ, projecting against the enamel germs, while the remainder atrophies. The two horns of the semilunar mass (as seen in section) extend from the base of the dental papilla some distance upward, and embrace the dentine germ and enamel organ."

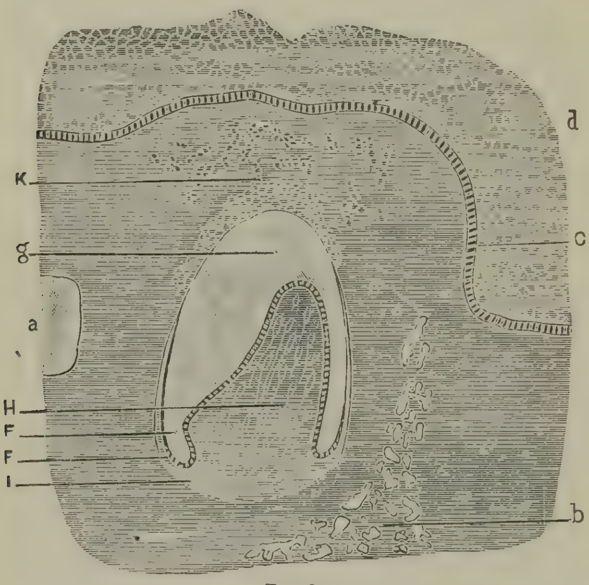

FIG. 89.

a. Meckel's cartilage. *b*. Traces of ossification. *c*. Lowest layer of Malpighian stratum. *d*. Oral epithelium. *F*. Ameloblastic or prismatic layer. Lower *F*. External layer of enamel organ *g*. Stellate reticulum of the enamel organ. *H*. Dental germ, or papilla. *I*. Follicular walls.

According to Dr. Sudduth, the epithelial cord does not penetrate the underlying tissue searching for a dentinal papilla, but it has the power to superintend the differentiation of a papilla for itself.

As the dentinal papilla or germ increases in height, it assumes a slightly oblique direction in relation to the axis of the follicle, and at the same time becomes constricted at its base, thus forming a neck at the line where the enamel organ is reflected back upon itself (Fig. 89).

The follicular wall, which forms a part of the dental follicle, first appears as a process arising from the base of the papilla, to the neck of which it is attached like a slight collar. Its development begins as

soon as the small mass which constitutes the dentinal germ assumes a hemispheric form. The follicular wall, by its gradual upward growth, at length embraces and isolates both the enamel organ and the dentinal papilla, and during its evolution, from being composed of embryo-plastic elements, by degrees assumes the appearance of a distinct laminated membrane, which may be separated from the adjacent tissue, except at the base of the papilla to which it remains adherent. According to both Kölliker and Huxley, the transparent stratum (*membrana præformativa*) which invests the dentinal papilla reflects itself back on its internal surface, and thus lines the whole inner surface of the follicular wall.

As the evolution of the follicular wall progresses, it closes over the contents of the dental follicle, which, besides the wall, consist of the enamel organ and the dentinal papilla; the enamel organ being subjacent to the follicular wall, to which it conforms in such a manner that, while the external face of the organ is in relation with the wall, the lower concave face is in immediate contact with the papilla. The dentinal papilla occupies the lower and central portion of the follicular sac.

FIG. 90.—*a*. Wall of the sac, formed of connective tissue, with its outer stratum a^1 and its inner a^2. *b*. Enamel organ, with its papillary and parietal layer of cells. *c*, *d*. The enamel membrane and enamel prisms. *e*. Dentine cells *f*. Dental germ and capillaries. *g*, *i*. Transition of the wall of the follicle into the tissue of the dental germ.

The enamel organ fills the entire space between the sac wall and the papilla, terminating at the base of the latter in a rounded margin which forms the dividing line between the prismatic cells which cover its concave and convex surfaces (Fig. 90). The dental follicle is of an ovoid form, and varies in size according to the class of tooth to be developed from it; and when it is completely formed, it remains inclosed within the embryonal tissues of the jaws, with which it is at first only slightly connected.

When the rupture of the epithelial cord occurs, it loses its communication with the mucous membrane, and forms no connection with the maxillary bone, as the alveolar processes are not developed until a later period.

The rupture of the epithelial cord, which brings about the isolation

of the dental follicle from the mucous membrane, is due to the upward growth of the follicular wall, which closes over the top of the enamel organ, beneath which is the papilla, the union of the edges of the wall producing compression or strangulation of the cord at that point. At this period of evolution, the saccular stage, the dental follicle is completed, and from the cells of the dentinal papilla a soft matrix of animal matter is formed, which becomes impregnated with calcareous matter to form the complete dentinal tissue, while in the interior of the cavity of the dentine cells are formed, which continue to form new matrix for a considerable time.

After the dentinal papilla has become coated over by the enamel organ, and the saccular stage of the teeth is produced, and the papillæ have become separated from each other by the developing tissue of the embryonic jaw, odontoblasts (dentine cells) begin to form. These odontoblasts are large nucleated cells of elongated form, containing numerous processes developed from the cells of the dentinal papilla, which at that early period consist of fine fibrous tissue with numerous cells.

The odontoblasts send out processes which, as they develop, calcify externally, the calcified portion forming the dentine, and the uncalcified part the dentinal fibrillæ, and the lateral branches of anastomosis whereby the tubuli or canals of the dentine anastomose. The remains of the odontoblasts form a cellular layer which constitutes the investment of the pulp lying between its nerves and vessels and the dentine. This cellular layer is known as the "ivory membrane"—*membrana eboris* of Kölliker.

The enamel organ is non-vascular, but a network of vessels is furnished to the follicular wall and the dentinal papilla from the surrounding tissues.

At the period when the epithelial cord is ruptured, the cells composing the epithelial lamina become greatly increased in number, and irregular proliferations or "buddings" occur, which wander by different courses into the deeper portions of the embryonal tissue. These buddings differ in form, sometimes in that of cylinders which retain their connection with the primitive lamina; but frequently this connection is absorbed, and an epithelial mass is set free. Clusters of these masses occasionally take the globular form, resembling those in the lamina itself, but frequently they become absorbed and disappear before the development of the tooth is completed. At the time the absorption of the epithelial lamina is taking place, changes precisely analogous are transpiring in the severed epithelial cord.

From the remains of this cord processes are given off, which at

times become quite numerous, and may remain almost to the time of the eruptive stage of the tooth.

The direction of these processes is toward the epithelium, and they consist of the same polyhedral cells as the cord and lamina, but are never invested with prismatic cells. All these epithelial proliferations finally disappear by absorption, unless some such masses may become detached and wander into the deeper tissues; for it is considered by some eminent histologists that a dentinal papilla or germ may originate from any point of the dentinal sheet of tissue with

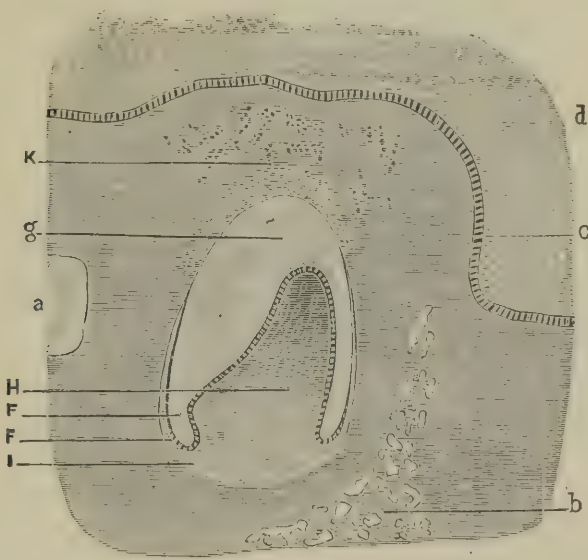

FIG. 91.

a. Meckel's cartilage. *b*. Traces of ossification. *c*. Lowest layer of Malpighian stratum. *d*. Oral epithelium. *F*. Ameloblastic layer. *Lower F*. External layer of enamel organ. *H*. Dentinal papilla. *I*. Follicular wall. *K*. Buddings of epithelial cord.

which the epithelial mass comes in contact, and that it is solely through the influence of the enamel organ upon this tissue that the development of the dentinal papilla is induced.

Immediately after the rupture of the epithelial cord, the formation of the secondary follicle of the permanent tooth begins. There is no trace of the osseous tissue of the jaw at the time of the origin of the primitive epithelial cord. Bone first makes its appearance near the base of the follicles, forming a horizontal layer, and separating the groove of the follicles from the canal reserved for the vessels and nerves. From the layer or floor, lateral processes arise and form the dental groove, in which the follicles remain for some time without

being separated by transverse partitions, and it is only after the development of the crowns of the teeth has commenced that bony processes are thrown across the groove, forming receptacles for the lodgment of each follicle with an opening in the direction of the epithelial surface (Fig. 92).

Development of Cementum (*Crusta Petrosa*).—There appears to be a difference of opinion among histologists concerning the origin of the cementum. Magitot, in 1858, and again Robin and Magitot, in 1861, described a new tissue, which, some time before the formation of the first dentine cap, was supposed to exist between the follicular wall and the organs within it—the enamel organ and the papilla—

FIG. 92.—FROM THE UPPER JAW OF A KITTEN, ABOUT THE TIME OF BIRTH.

a. Oral epithelium. *b*. Bone of jaw. *c*. Neck of enamel organ. *d*. Dentinal papilla. *e*. Enamel cells. *f*. Stellate reticulum. *h*. Germ or papilla of permanent tooth, the enamel organ of which is derived from the primary cord.

differing from the other tissues in color, consistence, and structure, and upon which the formation of the cementum depended.

On the other hand, Kölliker, Waldeyer, Hertz, Kollman, and others, deny the existence of such a membrane or tissue, and ascribe the formation of the cementum (which resembles ordinary bone, as it contains canaliculi and lacunæ) to a periosteal origin—that it is developed from the deeper tissues of the fetal jaw by periosteal ossification, the process being similar to that of bone formation in other parts of the body.

Origin of the Permanent Teeth.—While Goodsir held that the follicles of the permanent teeth originate from a fold of the sac of the primitive or deciduous follicle, the later investigations of Kölliker and Waldeyer have shown that the permanent follicles of teeth that

have deciduous predecessors arise from certain prolongations of the primitive epithelial cord.

The germ of the permanent follicle originates at a point where the primitive epithelial cord merges into the enamel organ of the temporary tooth, and is an outgrowth of this cord (see Fig. 93). The permanent cord takes a vertical direction, and passes between the bony alveolar wall and the primitive follicle, and then along the inner or lingual face of the follicle, its elements being the same as those of the primitive cord.

The permanent dentinal papilla or germ sinks to the bottom of the osseous dental groove, where it soon loses its connection with the primitive follicle, though still retaining its relation with the epithelial lamina.

The primitive follicle, however, by the severance of its cord at a point just below where the germ of the permanent or secondary cord arises, loses all connection with the epithelial lamina, and develops as an independent body or organ.

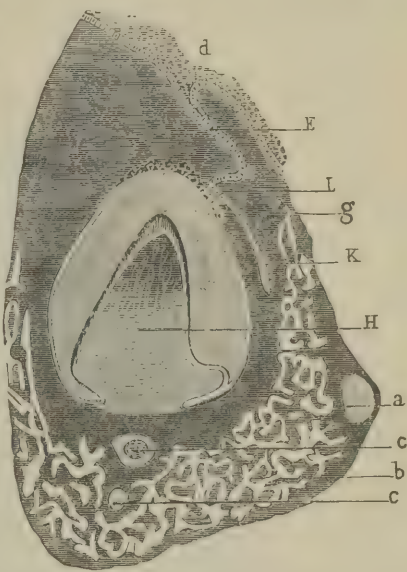

Fig. 93.—Section of the Lower Jaw of a Human Fetus.

9½ inches in length; corresponding to about the eighteenth week. (*Magnified 80 diam.*)

K. Cord or bourgeon of the secondary follicles. *L.* Points where its separation from the primitive cord is being effected. *a.* Meckel's cartilage diminished by absorption. *b.* Bone of the jaw. *c.* (Upper) dental artery; (lower) dental nerve. *d.* Epithelium. *E.* Originally the cord of the temporary follicle, but now the sole property of the permanent one.

The sinking of the follicle of the permanent tooth is soon followed by the entire series of phenomena which characterize the growth of every dental follicle; and while the permanent follicle is being developed, the remains of the ruptured primitive cord which continues to be attached to the primitive follicle are subject to that "budding" process which invariably commences at the moment this cord is severed—about the fourth month, or quickening period. The direction of the permanent cord being vertical, its length is governed by the height of the alveolar border and the direction of the primitive follicle. When sinking into the substance of the jaw, the permanent cord always assumes a spiral form, and to such a degree that it can be readily distinguished

from the primitive cord, as this latter is never so distinctly spiral in form as the former.

This spirality of form peculiar to the permanent cord is occasioned by the greater distance this cord must traverse in the more developed tissues of the jaw, to permit the permanent follicle to accomplish its passage to a point under the temporary tooth, and thus prevent the stretching of the cord and the disturbance of the parts with which the cord and enamel organ are connected. The spiral nature of the cord

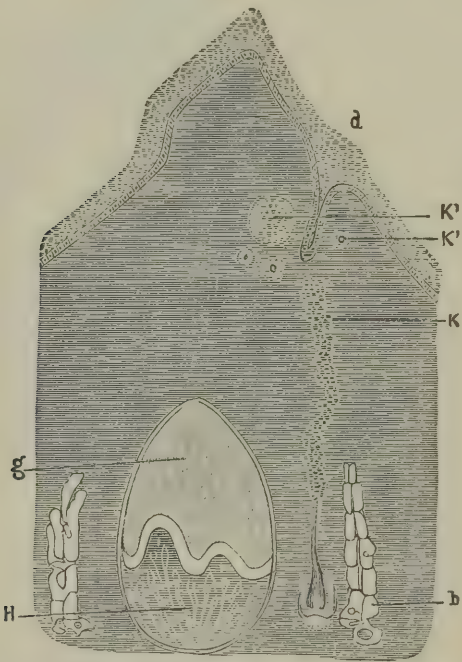

FIG. 94.—VERTICAL SECTION OF THE LOWER JAW OF A HUMAN FETUS.
Measuring 18¾ inches; corresponding to nearly the thirty-ninth week of gestation. The figure represents a cut passing through the follicle of a bicuspid.
b. Bone of the jaw. *d*. Oral epithelium. *g*. Enamel organ. *H*. Dental bulb. *K*. *Dêbris* of the cord of a permanent follicle. *K'*, *K'*. Epidermal globules. Follicle for the permanent tooth connected with the *débris* of its cord, *K*.

continues from its origin toward its termination in a rounded or club-shaped enlargement, similar to that of the extremity of the primitive cord, this enlargement representing the enamel organ of the permanent tooth.

At the period of the evolution of the permanent follicle, when the dentinal papillæ becomes unicuspid for the incisors and canines and multicuspid for the molars, the permanent epithelial cord, which has

already been for some time severed from the primitive cord and follicle, also loses its connection with the permanent follicle, and has no communication afterward with the epithelial lamina. This severance is soon followed by the separation of the permanent cord into fragments, which, as was before stated, bud and lengthen in different directions, and become mingled and confounded with those of the primitive cord, anastomosing with them to form a sort of plexus. Finally, all these epithelial masses atrophy and disappear.

The above description applies to the development of the permanent teeth that have temporary predecessors. But the origin of the permanent teeth that appear back of the temporary teeth, and have no deciduous predecessors, is entirely different.

The first permanent molar, the follicle of which makes its appearance during the fifteenth week of embryonal life, and only a few days after the greater number of those of the deciduous teeth, and yet does not erupt until about the sixth year, originates directly from the epithelium of the mucous membrane, the epithelial cord from which penetrates the fetal tissue in a region where no follicle has preceded it.

The second permanent molar originates from an outgrowth of the epithelial cord of the follicle of the first permanent molar, resembling in this respect the twenty anterior permanent teeth, but differing in the direction of its course. While the teeth derived from the temporary follicles pass over the lingual face of the latter to a position beneath them, that of the second permanent molar takes a horizontal direction for some distance, and then by an inflection takes its position at the posterior side of the follicle of the first molar, where it is developed in a line with those anterior to it (Fig. 92).

The origin of the third molar or wisdom tooth is effected in the same manner as that of the second permanent molar, as the epithelial cord that forms its enamel organ emanates from the cord of the second permanent molar. Hence we find the cord of the first permanent molar originating from the epithelium; that of the second permanent molar from the cord of the first permanent molar; and that of the third molar from the cord of the second permanent molar.

Dr. G. V. Black, whose extensive researches in dental histology are worthy of all praise, is of the opinion that, "although the epithelial cords of the twenty anterior permanent teeth generally arise from those of the temporary follicles, yet they do sometimes emanate directly from the epithelium of the mucous membrane."

If such is the case, the secondary or permanent epithelial cords may originate from either the primary cord, the temporary follicle, or the epithelial lamina. The follicles of the temporary teeth are developed during the period between the latter part of the third month of gesta-

tion and the beginning of the fourth year—within forty-two months—while the follicles of the permanent teeth require a much longer time for their evolution. It would seem quite reasonable to suppose that the dentinal papilla acts as an organic mold upon which the elements of the enamel are coated, but Magitot asserts that as the epithelial cord which represents the future enamel organ always precedes the appearance of the papilla, which is never formed until the cord has advanced a certain distance, this cord decides not only the *place of genesis*, but the *form* and function of the corresponding tooth. According to Dursy, a dentine germ or papilla may be developed from

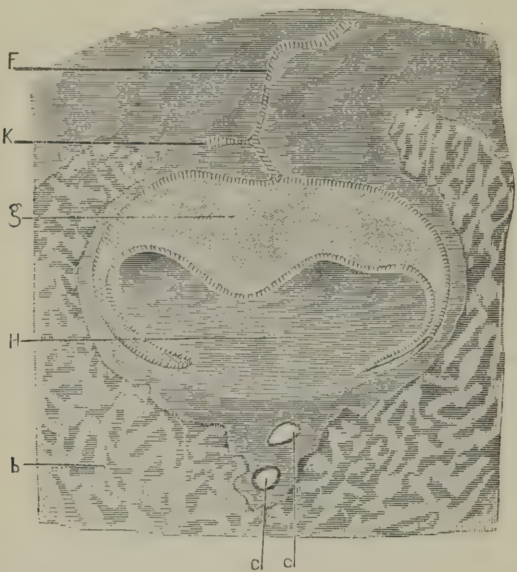

FIG. 95.—SECTION ON A LINE WITH THE FOLLICLE OF THE FIRST PERMANENT MOLAR. Human subject, three months after birth. (*Magnified 80 diameters.*)

b. Maxillary bone. *c, c.* Dental artery and nerve. *F.* Cord of the follicle of the first permanent molar. *g.* Enamel organ. *H.* Bulb of the first permanent molar. *K.* Bourgeon of the enamel organ of the second permanent molar.

any point of the semilunar area which is found below the enamel organ as soon as such a point is reached by this organ, and the dentine germ depends upon the course which the enamel organ takes. For example, if the epithelial cord of a canine should take an unnatural course, so as to come in contact with the dentinal tissue at a point between the bicuspids, the canine would be developed between those teeth; hence it seems reasonable to conclude that the enamel organ determines the form and character of the future tooth.

Although the proliferations or buddings of the remains of the epi-

thelial cord, after its severance from the enamel organ, usually disappear by absorption, yet it is possible that some such masses, meeting with dentinal tissue, may become the enamel organs of supernumerary teeth.

THE DENTAL PULP.

The pulp, occupying the central cavity in the crown of the tooth, called the *pulp-chamber*, and the *root-canal* in the root of the tooth, is composed of myxomatous connective tissue, in which are distributed blood-vessels and nerves, which enter the apical foramen of the root of the tooth. Near the middle of the root-canal, the small afferent artery, known as the *arteriole*, divides into small vessels,—capillaries,—and forms throughout the pulp-tissue a rich network, which terminates at the periphery of the coronal portion of the pulp in loops. (See Fig. 98.) The capillaries coalesce with a vein, which is a branch of the alveolar vein. Numerous bundles of nerves enter the substance of the

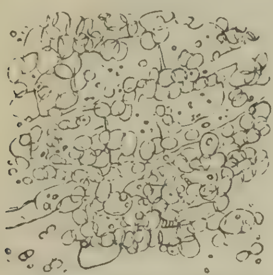

FIG. 96.—A PORTION OF THE BODY OF THE PULP, SHOWING THE CELLULAR ARRANGEMENT.

FIG. 97.—A PORTION OF THE SUPERFICIAL LAYER OF THE PULP, SHOWING THE APPEARANCE OF VESICLES.

pulp through the apical foramen of the root of the tooth, in the form of medullated nerve-fibres, which on approaching the periphery of the organ become non-medullated by the loss of their medullary sheaths, which is characteristic of all nerve-fibres in peripheral organs. During the development of the tooth, the external surface of the pulp is covered by a layer of protoplasmic cells, known as odontoblasts, and of which the fibrillæ of the dentinal tubuli are processes. The pulp of the completed tooth represents the shrunken condition to which the tooth-germ, or dentinal papilla, is permanently reduced after it has normally accomplished the work of dentinification, and affords the vascular and nervous supply of the dentine. In the development of the dentine, the thickening of the dentinal wall is produced by the primary single layer of odontoblasts, and this thickening is not only at the expense of the pulp-cavity, but of the pulp itself, which gradually diminishes in size as the dentine increases in bulk. The dental

pulp is an exquisitely sensitive, highly vascular substance, of a reddish-gray color, enveloped in an exceedingly delicate and apparently structureless membrane, continuous with the peridental membrane, and adherent to the walls of the pulp-cavity. This is designated by Pur-

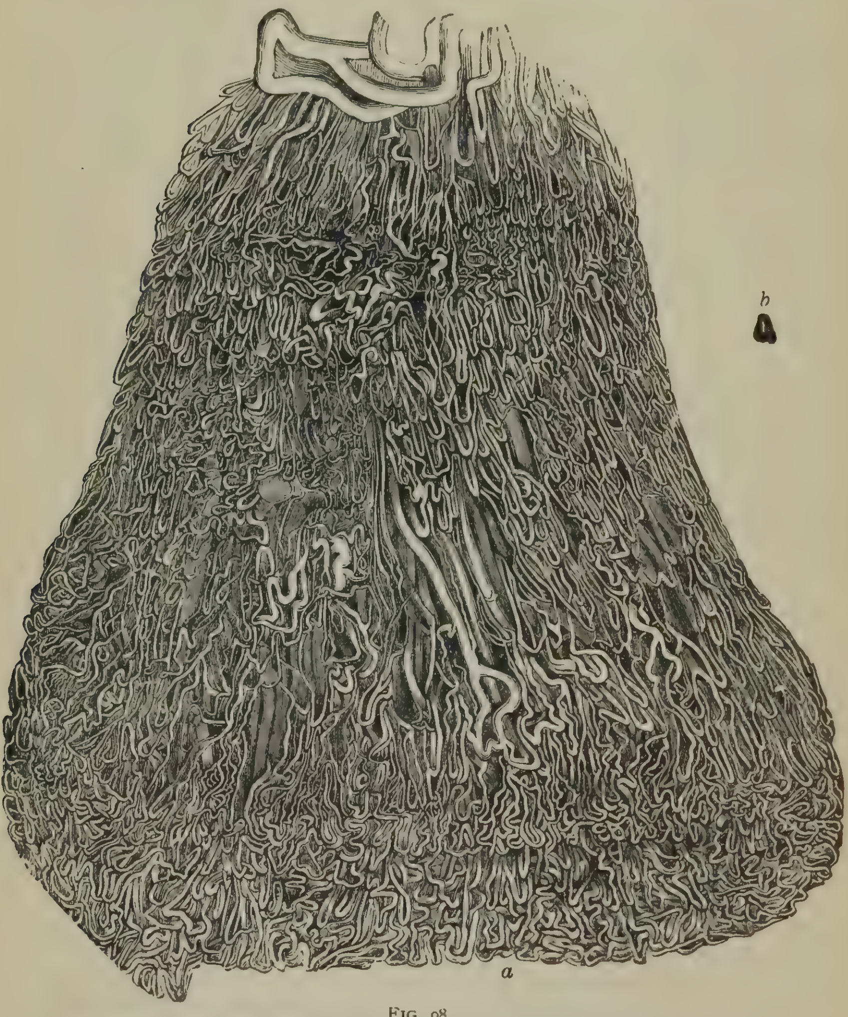

FIG. 98.
a. The vessels of the pulp of an upper central incisor injected, as seen under the microscope, very highly magnified. *b*. The natural size of the pulp.

kinjé and Raschkow, "the preformative membrane," because, in the formation of the dentine, the deposition of earthy salts, according to these authors, commences in it.

The pulp, according to the two last-mentioned authors, is composed of minute globules. Schwann describes it as consisting of globular, nucleated cells, with vessels and nerves passing between them, the cells having the same radical course as the fibres of the dentine. According to the microscopic observations of Mr. Nasmyth, it is principally composed of minute vesicular cells, varying in size from the ten-thousandth to the one-eighth of an inch in diameter, disposed in concentric layers; these, when macerated, have an irregular, reticulated appearance, and are found to be interspersed with granules, the parenchyma being traversed by vessels having a vertical direction. See Figs. 98 and 99, copied from Mr. Nasmyth.

FIG. 99.—THE NERVES OF THE PULP OF AN UPPER ADULT BICUSPID, MAGNIFIED TWENTY DIAMETERS.

Mr. Tomes describes it as consisting, from its earliest appearance, of a series of nucleated cells, united and supported by plasma; also, prior to the commencement of the formation of the dentine, of delicate areolar tissue, occupied by a thick, clear, homogeneous fluid or plasma. The pulp is liberally supplied with blood-vessels, furnished by the trunk which enters its base. The ramifications of these vessels are distributed throughout its entire substance, forming a capillary network which terminates in loops upon its surface.

Three or more arteries enter at the apical foramen, and supply the pulp, dividing into branches, which, after pursuing a parallel course, form a capillary plexus immediately beneath the cells of the *membrana eboris*, or ivory membrane. The nerves of the pulp enter the apical foramen by one large and three small trunks, and, like the arteries, pursue at first a parallel course, and about the middle of the root-canal form a rich plexus beneath the membrana eboris, or layer of odontoblasts.

The distribution of the vessels of the pulp is represented in Fig. 98, made from an injected preparation of an upper central incisor. The communication of the arteries with the veins by means of a series of looped capillaries, presenting a densely matted appearance upon the surface, is beautifully represented. The nerves of the pulp have a very

similar arrangement in their distribution, having apparently looped terminations (Fig. 99).

The dental pulp undergoes considerable change in advanced age, diminishing in size by its progressive calcification.

Further degeneration shows an atrophied condition of the odontoblastic layer, and coincidentally with the diminution in the quantity of the cellular elements, an increase of the fibrillar connective tissue. At last the capillary system becomes obliterated, according to Mr. Charles Tomes, "by the occurrence of thrombosis (effusion of blood into the cellular substance) in the larger vessels, the nerves undergo fatty degeneration, and the pulp becomes a shriveled, unvascular, insensitive mass."

CHAPTER XII.

TOOTH STRUCTURES.

ENAMEL.—With regard to the formation of the enamel, the dental follicles have their origin in a cord which emanates from the epithelial layer of the mucous membrane of the mouth. These cords arise directly from a process of the oral epithelium, those of the permanent teeth, which succeed the deciduous ones, being outgrowths from the primitive cords. Concerning the cords of the other permanent teeth, those for the first molars originate directly from the epithelium of the mucous membrane, and the remaining ones from the cords of the preceding molars. The enlarged extremity of the cord constitutes the *enamel organ* of the future dental follicle. (See Origin and Formation of the Teeth.)

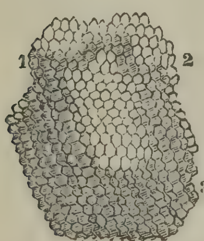

FIG. 100.—THE HEXAGONAL TERMINATION OF THE FIBRES OF A PORTION OF THE SURFACE OF THE ENAMEL; HIGHLY MAGNIFIED.

At 1, 2, 3, the crooked crevices between the hexagonal fibres are more strongly marked.

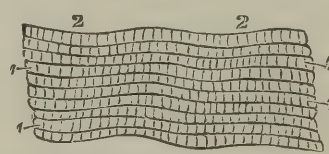

FIG. 101.—A SIDE VIEW OF THE ENAMEL FIBRES; MAGNIFIED 800 TIMES.

1. The enamel fibres. 2,2. Transverse striæ upon them.

When the enamel is first deposited upon the surface of the dentinal papilla, it is of a chalky appearance, and afterward attains the glossy

hardness by which it is characterized, with a white appearance, like porcelain.

The enamel forms a smooth, dense layer enveloping the crown of the tooth as far as the neck, where it insinuates itself between the cementum and dentine. It is thickest on the cutting edges and grinding surfaces of the teeth, tapering to a thin edge at their necks. In color it is rather translucent than white. The analysis of enamel consists of

Calcium Phosphate,	85.3
Calcium Carbonate,	8.0
Calcium Fluorid,	3.2
Magnesium Phosphate,	1.5
Sodium Salts,	1.0
Animal Matter and Water,	1.0

Von Bibra gives the following:—

	Adult Man.	*Adult Woman.*
Calcium Phosphate and Fluorid,	89.82	81.63
Calcium Carbonate,	4.37	8.88
Magnesium Phosphate,	1.34	2.55
Other salts,	.88	.97
Cartilage,	3.39	5.97
Fat,	.20	a trace
Organic,	3.59	5.97
Inorganic,	96.41	94.03

Enamel consists of hexagonal or polygonal fibres or rods arranged in waved lines perpendicularly to the dentine. Those fibres or rods, situated on the most prominent part of the crown, are arranged in a vertical direction; those upon the side are placed horizontally, whilst the intermediate fibres present all degrees of obliquity. As these fibres necessarily diverge from the dentinal to their free surface, the upper space thus occasioned must be filled by the gradual enlargement of the fibres from within outward or by the addition of supplemental fibres.

FIG. 102.—HUMAN ENAMEL FROM THE MASTICATING SURFACE OF A MOLAR.
The figure is merely intended to show the general direction of the fibres.

The enamel rods are marked by transverse striæ, which indicate, according to Mr. Beale, the successive layers of calcification, and are

much more strongly pronounced in some specimens than in others, being most markedly so in the enamel of unhealthy subjects.

Fig. 103.—Cavities in Human Enamel Which communicate with the dentinal tubes.

Upon opening a dental sac from a fetal jaw, interposed between the inner surface of the sac and the coronal surface of the tooth, a semi-fluid, gelatinous substance will be found, composed of nucleated cylindrical columns with more or less spherical nucleated cells enveloped in fluid. Similar columns will be found on the inner surface of the sac. This is the enamel organ, or enamel pulp, and from it the cells found in the gelatinous fluid have become separated. Columns of a like kind are also found on the surface of the enamel. When the tooth makes its way through the gum, and before it has suffered from friction, by the action of hydrochloric or acetic acid, a membrane-like surface (Nasmyth's membrane) may be raised from the surface of the enamel; it is soon worn away from the crown of the erupted tooth.

This membrane, to which Mr. Nasmyth first drew attention, has been described as the persistent dental capsule, and consists of a delicate pellicle, exceedingly thin, of a reticulated pattern and of a horny nature, and is indestructible by both acids and alkalies. According to Tomes, Nasmyth's membrane is a thin layer of cementum; according to Kölliker, it is a final product of the enamel cells; according to Waldeyer, it is derived from the external enamel epithelium; according to the latest theory, that of F. T. Paul, it is of an epithelial nature, consisting of a layer of polygonal, flattened epithelium, measuring about 1–2000th inch broad, and up to 1–1000th inch long, placed upon a thin, structureless, elastic membrane, the external enamel

epithelium coming in contact with and adherent to the surface of the enamel.

The enamel differs from dentine in its greater density; the much earlier period at which entire calcification takes place; the absence, except in abnormal conditions, of any uncalcified portions; the direction in which calcification progresses; and in the fact that it is the least constant of the dental tissues. In pathological conditions irregular cavities are sometimes found in the enamel near to the surface of the dentine, and in such cases the dentine tubes may communicate with them (Fig. 105). In some cases the dentinal tubes may enter the enamel, but this condition is more common to some animals than to the human subject. "It is more frequently absent than present in the teeth of the class of fishes; it is wanting in the entire order Ophidia among existing reptiles; and it forms no part of the teeth of the Edentata, and many cetacea among mammals." (Owen's "Odontography," xxiv.) The nutrition of the enamel is yet a mooted question, but that this process is extremely slow is beyond doubt. Sensitiveness of the enamel is denied by R. Baum and others; but Bödecker* thinks that the simple experiment of eating a sour apple, which in perfectly sound teeth "sets them on edge," is a proof of the sensitiveness of the enamel, and he believes that the pain is due to living matter in normal enamel and the transmission of its contractions to that of the dentine. It is well known that under morbid conditions the enamel may become very sensitive. Dr. Bödecker, therefore, believes in the existence of what he designates as *enamel fibrillæ* in the interstices between the enamel prisms.

Dentine.—With regard to the manner of the formation of the dentine, the first step in this process is the development of the odontoblasts, which have the same relation in the development of the teeth as osteoblasts have in the formation of bone. The odontoblasts are large nucleated cells, of elongated form, provided with numerous processes developed from the dentinal papilla, which at that early stage consists of fine fibrous tissue containing many cells. The odontoblasts send out processes, which, as they develop, become calcified externally, the calcified portion forming the dentine, and the uncalcified part the dentinal fibrillæ, and the lateral processes the branches of anastomosis through which the tubuli or canals of the dentine communicate.

The remains of the odontoblasts themselves form the investment of the pulp, situated between its nerves and vessels and the dentine, a cellular layer known as the *membrana eboris*, or ivory membrane of

* "Anatomy and Pathology of the Teeth."

Kölliker. (See Origin and Formation of the Teeth.) The dentine is deposited around the fibrils of the odontoblasts, the latter occupying a position nearly at right angles to the surface of the dentine, the deposition being in the protoplasm which is found in interspaces between the fibres. Lime salts being deposited in the protoplasmic basis substance, the odontoblast, as the process of secretion proceeds, becomes enclosed in a thin spherule of formed material, known as "calcoglobulin," * and the dentine substance or tissue assumes the form of a homogeneous mass, traversed by tubes which contain the dentinal fibrils.

The greater portion or body of every tooth is composed of dentine, which is a yellowish-white, semi-transparent, hard, elastic substance, and intermediate in consistence between the enamel and the cementum. In a normal condition the dentine is never exposed, being covered in the crown of the tooth by the enamel, and in the root by the cementum.

In a fresh specimen the human tooth is found to consist of 62 per cent. of its weight in organic salts, 28 per cent. of tooth cartilage (organic matter), and 10 per cent. of water.

Berzelius gives the following analysis of dentine :—

Calcium Phosphate,	62.00
Calcium Carbonate,	5.50
Calcium Fluorid,	2.00
Magnesium Phosphate,	1.00
Sodium Salts,	1.50
Gelatin and Water,	28.00

Von Bibra gives—

Calcium Phosphate and Fluorid,	67.54
Calcium Carbonate,	7.97
Magnesium Phosphate,	2.49
Salts,	1.00
Fat,	.58
Cartilage,	20.42

While the organic basis of the matrix of dentine is similar to that of bone, yet it is not identical, being of firmer consistence, and does not yield gelatin when boiled. A fresh section of dentine presents a satiny aspect, but when submitted to the microscope it is found to consist of a multitude of fine tubes, known as the *dentinal tubuli*,

* Calcoglobulin is a term applied to a thin layer of partially calcified tissue, found between the organic and inorganic tissue in the development of bone, dentine, and cementum.

with an *intertubular substance.* These minute tubes permeate the entire structure of the dentine, their direction varying in the different parts of the tooth. Each tube originates by an open, circular mouth or orifice upon the surface of the pulp-cavity, where it runs toward the periphery of the dentine in a direction usually perpendicular to the surface, just before reaching which it divides into branches.

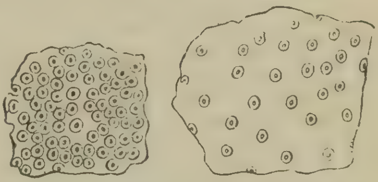

FIG. 104.—TRANSVERSE SECTION OF DENTINE.

Proceeding in a wavy and radiated manner throughout every portion of the dentine to its periphery, these tubes, although generally terminating at that point, in some instances extend beyond and encroach upon the enamel or upon the cementum. When the latter is the case, they may communicate with the canaliculi and lacunæ.

Toward the grinding surface of the crown of a tooth, when occlusion is received, these tubes have a vertical direction, and a horizontal

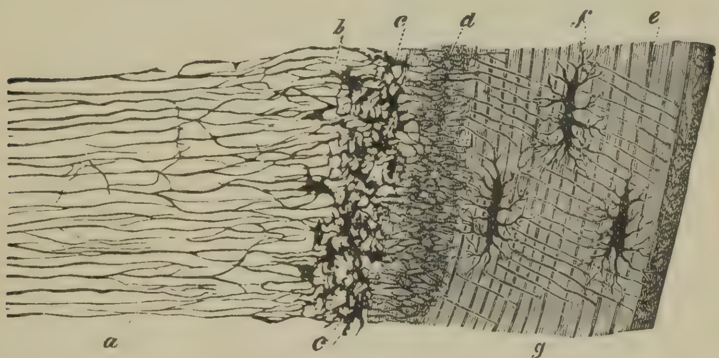

FIG. 105.—DENTINE AND CEMENTUM FROM THE ROOT OF A HUMAN INCISOR; COPIED FROM KÖLLIKER.

a. Dentinal fibres or tubes. *b.* Interglobular spaces, having the appearance of the *lacunæ* in bone. *c.* Smaller interglobular spaces. *d.* Commencement of the cementum, with numerous canals close together. *e.* Its *lamellæ*. *f. Lacunæ*. *g.* Canals.

direction when the pressure of adjoining teeth has to be resisted; and thus the shock of occlusion and pressure is more generally distributed over the entire tooth structure. These dentinal tubes, instead of pursuing a straight course, describe curves, the longer ones less abruptly defined than the others, and are termed "primary curvatures," the latter being more common to the crown than to the root. The secondary curvatures, although smaller than the primary, are much more numerous. The coincidence of the primary curvatures of adjoining dentinal tubes, or the presence of rows of what are known as "interglobular spaces" (Fig. 105), may occasion a striated or laminated ap-

pearance of the dentine, the lines thus formed being at nearly right angles with the tubes and known as the *contour* lines of Owen. They proceed in an arched manner, somewhat parallel to each other.

The dentinal tubes are cemented together by a sub-granular matter, radiating from the cavity to the surface of the tooth. From these tubes branches are given off in great number in the roots and as the enamel approaches the dentinal surface. In the crown these branches are few in number. They anastomose freely with each other and with the superficial dental tissues. They terminate in loops or are lost in the enamel. By their extension into the superficial dental tissues a close union is formed between them and the dentine, notwithstanding the fact that each tissue is developed from a distinct formative pulp. Kölliker thought these tubes contained clear fluid in the fresh state. In the dried preparation they are empty, and are readily permeated by colored fluid. These facts give rise to the opinion that their sole purpose was the conduct of nutrient fluids. Mr. Tomes, however, following Nasmyth, objected to this theory on purely physiological grounds. The extreme sensitiveness of an exposed coronal surface from which a portion of enamel has been broken; the fact that in operations for the removal of carious dentine the sensitiveness was found to be greatest just beneath the enamel; and furthermore, that when the pulp was broken up or destroyed by escharotics, this sensibility was lost, led him to conclude that the sensibility of the dentine depended on its connection with the pulp, and to suppose that these tube-contents might be in some way associated with the sensibility of the structure in which they were found, serving to establish connection between it and the pulps, to which supposition fluid contents opposed an insurmountable difficulty. Led by this train of reasoning to a careful examination of the tubes, he found each dentinal tube tenanted by a soft fibril, which, after passing from the pulp into the tube, follows its ramifications, and that these fibrils may be traced into the substance of the pulp. Kölliker and Lent were the first to determine the connection of these fibrils with the odontoblasts of the pulp.

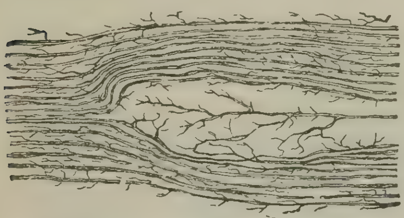

Fig. 106.—Termination of a Dentinal Tube in the Midst of the Dentine—Human.

Fig. 107.—A Fragment of Dentine.
a. Through which run the softer fibrils, *c*, which seem to be continuous with the odontoblast cells, *b*. (*After Dr. Lionel Beale.*)

Mr. Tomes says: "It is by no means necessary to assume that the dentinal fibrils are actually nerves before allowing them the power of communicating sensation. Many animals are endowed with sensation which yet possess no demonstrable nervous system;" whilst, at the same time, it has been impossible to demonstrate nerves in the human body so numerous as to warrant the assumption that at every prick of a needle the point must touch a nerve fibre. Again, the greater sensibility of the dentine immediately beneath the enamel is satisfactorily accounted for by the law which refers to all nerves the greatest sensibility at their terminal extremities. He also thinks "the foregoing facts will warrant the conclusion that the dentinal fibrils are subservient to sensation in the dentine, since, when their connection with the pulp is cut off, all sensibility is lost to the dentine."

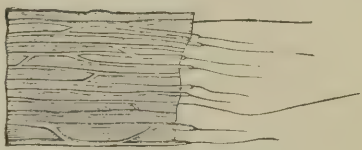

FIG. 108.—SECTION OF DENTINE.
From the edge of which hang out the dentinal sheaths; and beyond these again the fibrils. (*After Boll.*)

Dr. Bödecker,* on the other hand, claims that he has demonstrated by careful investigations that the dentinal fibrillæ are not nerves, but formations of living matter, and gives the following reasons for this opinion: "First, that it is impossible to admit of a connective tissue holding nerves alone in its constituent soft parts. Second, neither have we, nor has G. Retzius, been able to trace a direct inosculation of the dentinal fibrillæ with the axis-fibrillæ of the nerves so abundantly distributed throughout the periphery of the pulp-tissue." And he further says that as soon as we admit that the dentinal fibrillæ are formations of living matter, the same as are the nerves, all difficulties vanish in explaining the transmission of sensation from the periphery of the dentine to the nerve of the pulp-tissue. Living matter is, according to Heitzmann, contractile matter. Nerves are made of living matter, and owing to their reticulated or beaded structure, are fittest for that transmission of contractions from the periphery to the nervous centres which we call sensation. Contraction of the dentinal fibres transmitted into the reticulum of the protoplasm at the periphery of the pulp, and thence into the ultimate nerve fibrillæ,—all of which formatives are proven to be con-

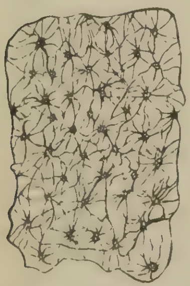

FIG. 109.—TRANSVERSE SECTION THROUGH THE DENTINAL TUBULI OF THE ROOT OF A HUMAN TOOTH.
Magnified 350 diameters, showing their numerous anastomoses.

* "Anatomy and Pathology of the Teeth."

tinuous,—are sufficient to explain the transmission of sensation, or, speaking bluntly, of pain."

The dentinal fibrillæ appear to be formed by the peripheral portions of the processes of the odontoblasts, after the latter become long and narrow, attaining considerable length.

The formation of dentine begins about the fourth month of fetal life, at the summit of the papilla. The superficial portion of the crown is first formed, and afterward undergoes no alteration in size, all subsequent growth taking place on the surface adjacent to the dentinal pulp. The growth of the root takes place from above, downward into the alveolus destined to receive it. Placed at right angles to the outer surface of the pulp, between it and the dentine already formed, or before any dentine is formed, is situated a layer of "elongated cylindrical bodies of cells, with nuclei" somewhat resembling nucleated, columnar epithelium. With regard to the exact share taken by the pulp in the formation of dentine, Kölliker says a layer of cells forming the peripheral portion of the pulp are immediately concerned in its formation. He does not consider that the "same cell suffices for the whole duration of the dentine," but that new cells may from time to time be formed; and denies that the whole pulp is progressively changed into dentinal cells, and thinks its only purpose is to support the vessels essential to the growth of the dentinal cells, from which alone the dentine is formed, by the gradual reception of calcareous salts. (From "Tomes's Dental Surgery," 388.)

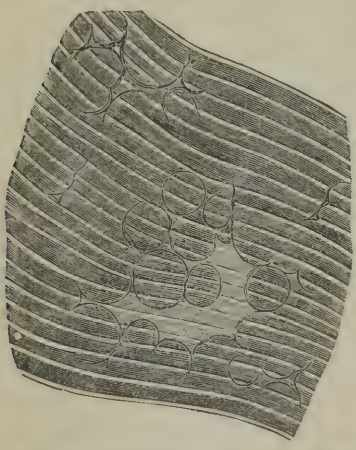

FIG. 110.—INTERGLOBULAR SPACES IN DENTINE.

Prof. Christopher Johnson, of Baltimore, succeeded in tracing communication between the fibrillæ of the dentine and the odontoblasts of the pulp—and to it we must refer the sensibility of this tissue.

On account of the tubes dividing into minute branches, as they approach the surface of the dentine, they appear to end in very fine-pointed extremities. Some of these tubes anastomose with the branches of others, forming loops near the periphery, while others terminate deeper in the tissue. The inner walls of the tubes surrounding the fibrillæ constitute the dentinal sheaths, which are apparently of fibrous structure.

The *intertubular tissue* contains the greater part of the earthy

constituents of the dentine, and under the microscope presents a granular appearance.

What are known as *interglobular spaces* are indicators of arrested development of the dentinal tissue, and are not considered to be normal. These spaces are dark and irregular, and are most commonly observed a little distance below the surface in a discolored and imperfectly developed tooth; they have a ragged outline. According to Bödecker, soft, living plasm is found in the smaller interglobular spaces.

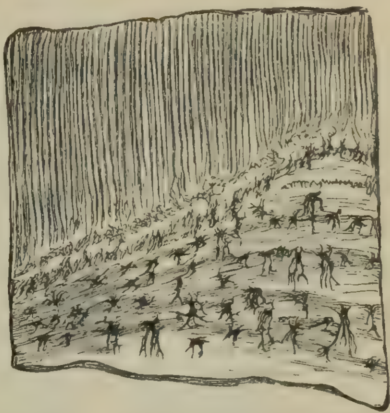

FIG. 111.—THICK LAMINATED CEMENTUM. From the root of a human tooth.

According to Krause, dentine has a specific gravity of 2.080, and contains less earthy matter than the enamel, but more animal substance, which accounts for the rapid progress of caries when the dentine is exposed.

CEMENTUM.—Cementum is developed from the deeper tissues of the fetal jaw, precisely like bone is produced in other parts of the body, by periosteal ossification, and is modified bone-tissue peculiar to the structure of the teeth. It contains canaliculi and lacunæ, and, according to Salter, Haversian canals in the thicker portion.

It is not so dense as the dentine, and approaches more nearly in character true bone, which is necessary in order that the tooth may be tolerated by the more highly vitalized structures in relation with it.

The analysis of cementum is as follows:—

Calcium Phosphate and Fluorid,	58.73
Calcium Carbonate,	7.22
Magnesium Phosphate,	0.99
Salts,	0.82
Cartilage,	31.31
Fat,	0.93

The Cementum, or *Crusta Petrosa*, is the most highly organized of the dental structures. Generally the cementum is covered on its external periphery by a layer of calcified protoplasmic cells similar to bone-cells, *osteoblasts*, which are in connection with the fibrous connective tissue of the peridental membrane. At the neck of the tooth

it is composed of calcified basis-substance, penetrated by spindle-shaped protoplasmic cells. In the root portion there is a distinct lamellation, where are presented the *cement-corpuscles*, which closely resemble bone-corpuscles. Cementum covers the roots of all the teeth, encroaching slightly upon the crown, where it overlaps the enamel. Its purpose is to bind the teeth securely in the alveoli, forming the vital bond between the bone and the commonly unvascular constituents of the teeth. It is thickest about the terminal part of the root, gradually thinning as it approaches the crown. In the thicker parts the canaliculi are seen anastomosing freely with each other, and establishing vascular relations between the several lacunæ; and they occasionally become connected with the terminal branches of the dental tubuli. Haversian canals, as was before remarked, are also found in very thick sections of cementum. The lacunæ and canaliculi of cementum are distributed lengthwise around the root, those in proximity to the dentine joining with the terminal branches of the dentinal tubuli, while those upon the external surface radiate toward the investing membrane.

FIG. 112.—LACUNA OF CEMENTUM, Which communicates with the termination of the dentinal tubes.

By such a provision, even after the devitalization and removal of the pulp, the vitality of the cementum of the teeth is maintained.

From irritation of the peridental membrane the cementum often becomes hypertrophied, the affection being known as "hypercementosis" Cementum contains more animal matter than the dentine, and becomes very sensitive when exposed by the recession of the gum about the neck of the tooth.

OSTEO-DENTINE.—Osteo- or secondary dentine is a substance partaking more of the nature of cementum than of ordinary dentine, as it possesses no true dentinal tubes, but canals similar to the canaliculi of bone. It is generally formed in the teeth of persons of advanced age, where the pulp-cavity is very much diminished in size, and it also forms a protection against the exposure of the pulp of the tooth which has been denuded of its natural tissues by mechanical abrasion, the action of caries, or by fracture. In other cases secondary dentine is deposited in isolated nodules scattered throughout the substance of the dental pulp, which may unite and form larger masses and become adherent to the walls of the pulp-cavity. Some of these masses are occasionally penetrated by blood-vessels and surrounded by concentric lamellæ, like the Haversian canals of bone.

The dividing line between the primitive and secondary formations of dentine is characterized by numerous irregular spaces and globular contours, while deeper in the mass of lately formed secondary dentine tubes or canals may exist.

FIG. 113.—SECONDARY DENTINE,
Filling up one of the cornua of the pulp-cavity. From a human molar affected by caries.

Not infrequently, however, the tubuli of secondary dentine are arranged in a very irregular manner, either "in tufts or in bundles, and without any apparent reference to points of radiation." Osteodentine is also usually very transparent, on account of this tissue being devoid of light-refracting tubes, its canals being so completely filled up with the secondary deposit that they permit the transmission of light. The tubuli of normal dentine are frequently filled with a secondary deposit, especially in the roots of teeth, and to which the name "horny dentine" has been given. The formation of secondary dentine appears to depend upon irritation of the pulp, of long continuance but restricted as to degree, and during the time "that the slow conversion of the organ is taking place the dentinal fibrillæ also become impregnated with calcareous matter and solidify."

Mr. T.
[illegible]

~~[illegible]~~
Human female
pelvis, ~~[illegible]~~ of abdomen,
&c.
4002 anat. series.
A[illegible] [illegible] of
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PART SECOND.

DENTAL PATHOLOGY, THERAPEUTICS.

CHAPTER I.

THE TEMPERAMENTS IN RELATION TO THE TEETH.

THE individual conditions or qualities known as temperaments exercise an influence upon the teeth, as well as upon the other functional operations of the body. The word temperament is derived from the Latin *tempero*, "to mix together," and implies the constitution as determined by the predominance of certain constituents of the body. For among the ancients it was supposed that the manifestations of the functions were tempered or so determined by the predominance of any one of the three humors then recognized, namely: blood, lymph, bile, and atrabilis, or black bile. Dunglison, in his Medical Dictionary, defines the temperaments to be those individual differences which consist in "such disproportion of parts, as regards volume and activity, as to sensibly modify the whole organism, but without interfering with the health;" in other words, a physiological condition in which the functions of the different organs are so regulated as to impress certain characteristics upon each individual. Others contend that these individual differences, "though they can scarcely be called morbid, yet certainly give a proclivity to disease in the direction indicated by the temperaments."

Dr. James W. White, on this subject, remarks: "Temperament may be defined as a constitutional organization, depending primarily upon heredity—national or ancestral—and consisting chiefly in a certain relative proportion of the mechanical, nutritive, and nervous systems, and the relative energy of the various functions of the body—the reciprocal action of the digestive, respiratory, circulatory, and nervous systems. The stomach, liver, lungs, heart, and brain—digestion, assimilation, respiration, circulation, and innervation—are all factors in the differentiation of temperament; and according to the congenital predominance of one or the other, and the relative activity of these functions, is the modification of the characteristics of the individual which determines his position as to temperament. Each temperament is the result as well as the indication of the preponderance of one or another of these systems, and of relative functional activity.

"A perfect equilibrium of the different systems is rarely if ever presented in any individual. One having a balance of all the temperaments would be temperamentless, or of no special temperament. It is difficult, in some cases, to decide positively to which variety a special case belongs, the several temperaments being combined and blended in such ever varying proportions. Not infrequently the indications

are even contradictory, and the blending of several temperaments requires a nice discrimination to define the admixture. The primary elements of temperament are susceptible of such manifold combinations; the determining forces are so complex, and our knowledge of their comparative values is so limited, that no rule can be given which will not fail in numerous instances to apply in all respects to individual cases; but that there is a general relation between constitutional qualities and external signs does not admit of question.

"Temperaments are readily divisible into four basal classes—bilious, sanguineous, nervous, and lymphatic; then again into sub-classes of mixed temperaments—a combination of two or more of the primary divisions. In these combinations one or other of the so-called basal temperaments predominates, and a compound term is used to express the complexity, as, for instance, the nervo-bilious, signifying that the bilious base—the foundation temperament—is qualified by an admixture of the nervous element, and so throughout the series. Twelve varieties of temperament, in addition to the four basal, may thus be designated by the combination in pairs of the original four. The admixture of the peculiarities of three or of all four of the basal temperaments results in what are denominated respectively ternary and quaternary combinations, which call for nice discrimination in diagnosis; but even such complexities are registered in the size, form, and color of the dental organs."

The *sanguineous* temperament is characterized by a fair, ruddy complexion, yellow, red or light auburn, or light-brown hair, a good class of teeth, a full muscular development, large, full veins and active pulse, indicating an abundant supply of blood, and warm extremities, all showing perfect health, and in females a tendency to voluptuousness. The mind is hopeful and elastic, yet at the same time fickle and volatile, with little determination and perseverance. Although indicating perfect health, yet in this temperament diseases are prone to assume the acute form, and speedily run their course either to recovery or a fatal termination.

The *bilious* temperament is characterized by a preponderance of bile, indicated by a dark or sallow countenance, black hair, generally luxuriant, a slow or moderate circulation of the blood, shown by a hard, strong pulse, dark eyes, strong teeth, with a yellow tinge over the entire crown; and the body, instead of the roundness of form peculiar to the sanguine temperament, is angular; wanting in ease and grace of manner; there is restlessness, but at the same time great force of character and quickness of perception and power of will. The digestive organs, however, are more liable to derangement than in other temperaments, indicating some defective action

in these organs; the liver, of course, being the principal one affected, and necessitating the use of mercury as a stimulus.

The *lymphatic* temperament is characterized by a predominance of lymph or phlegm in the system; and persons possessing it have a general softness or laxity of the tissues, the proportion of the fluids being too great for that of the solids, the lymphatics and absorbents not acting so thoroughly as to prevent the cellular tissue from being filled with humors; so that there is a want of sensibility. The complexion is fair, but not ruddy, and the hair, either light or dark, is not luxuriant, but thin and straight. The eyes are light, generally blue, the circulation feeble, and the pulse, as a consequence, weak, and a want of tone in the system. The skin is pale, flabby, and moist, and the body is heavy and rounded, while the teeth, although they may often appear comparatively good, yet are sensitive and not highly organized. Although the expression denotes a want of activity, yet there is a clear and active mind, characterized by prudence and sound judgment without enthusiasm. Owing to the predominance of lymph, there is a tendency to dropsy and chronic disease.

The *nervous* temperament is characterized by the predominance of the nervous element, and by great activity or susceptibility of the great nervous center—the brain. Persons possessing this temperament are distinguished by their impressibility, susceptibility to intense feeling or intense excitement. There is great irritability, anxiety, and agitation, which peculiarities enable us readily to recognize it by the tone of voice and manner of speaking. The body is slender, though well formed, the complexion pale and soft, and the muscles small and yielding. In illness, symptoms are often complicated with those of nervous disorder, and the mind desponding. There is want of power and endurance.

Upon the temperament the constitutional health depends to a greater extent than pathologists generally admit; and hence it is that that of the child usually partakes of that of one or other, or both, of its parents. "This," says M. Delabarre, "is particularly observable in subjects that have been suckled by a mother or nurse whose temperament was similar to theirs." To obviate the entailment of this evil, he recommends mothers having teeth constitutionally bad to abstain from suckling, and that this highly important office be intrusted to a nurse having good teeth; asserting at the same time, that by this means the transmission of so troublesome a heritage as bad teeth may be avoided.

Dr. J. Foster Flagg gives the following tabular presentations of the relation of the temperament to the teeth:—

THE TEETH AS INDICATED BY TEMPERAMENT.

General Divisions.	Bilious.	Sanguineous.	Nervous.	Lymphatic.
General Color and Quality of Color, ...	Bronze-yellow, with strength or power of coloring.	Cream-yellow, and inclined to translucency.	Pearl-blue or gray; inclined to transparency.	Pallid and opaque, or muddy in coloring.
General Form, ...	Large and inclined to angular; rather long in proportion to breadth.	Well proportioned; abounding in curved or rounded outlines; cusps rounding.	Length predominating over breadth; fine, long, cutting edges and cusps.	Large, but not shapely; breadth predominating over length; cusps poorly defined.
Surfaces of the Teeth, . . .	Inclined to transverse ridges, and abounding in strong lines; neither brilliancy nor transparency of surface, but slight translucency.	Smooth, or nearly so; elevations and depressions rounded; cutting edges and cusps translucent. Fair degree of brilliancy.	Brilliant and transparent depressions and elevations; abounding in long curves.	Surface of incisors devoid of depressions or elevations; opaque and dead in finish, even to cutting edges.
Articulation, ...	Firm and close; well locked.	Moderately firm; jaw inclined to rotate in mastication.	Very long and penetrating.	Loose and flat.
Gum Margin or Festoon, . .	Heavy and firm, but inclined to angularity.	Round and full, as regards both breadth and depth.	Delicate, shapely, and fine; oval in curve.	Thick and undefined in shape.
Rugæ, ...	Heavy and rugged in shape; squarely set.	Numerous and graceful in outline; not heavy, but well rounded.	Close, not numerous; small and long.	Sparse and flat.

CHARACTERISTICS OF THE TEETH.

Most dental physiologists have observed the marked differences that exist in the appearances of the teeth, gums, lips, tongue, and secretions of the mouth of different individuals; and of that earthy substance (commonly called tartar), deposited in a greater or less abundance on the teeth of every one; and, although all may not have sought their etiology, many have had occasion to notice, at least, their local indications, and to profit by the information which they have thus obtained. Nor have they failed to observe that the size, color, length, and arrangement of the teeth vary, and that these are indications of their susceptibility to disease.

There are five principal classes or descriptions of teeth, each of which differs, in some respects, from the others, a knowledge of which is very essential to the dental practitioner, in order that he may determine their liability to decay, strength of attachment, and the form and size of their roots.

Class First.—The teeth belonging to this class are white, with a light cream-colored tinge near the gum, which becomes more and more apparent as the subject advances in age, of a medium size, rather short than long, with thick, square edges; those of each class of uniform dimensions, and very hard. This description of the teeth is most frequently met with in persons of sanguineous temperament, or, at least, those in whom this predominates; they rarely decay, and generally occupy their proper position in the dental arch; the most common deviation, and one most peculiar to this class, is that of the superior incisors antagonizing with the inferior, causing the form of abrasion known as mechanical. They are not as easily acted upon by corrosive agents, and caries attacking them, usually of the black variety, makes but slow progress, and often exists for a considerable time without causing pain or inconvenience. Operations performed upon teeth of this class are those, above all others, on which we can predict the most perfect success. They indicate, if not *perfect* health, at least a state which bordered very closely on it at the time of their dentinification.

This first description of teeth is occasionally found among persons of all nations. They are very common in cold and temperate climates, and those who have them usually enjoy excellent health.

In confirmation of what has before been said with regard to the influence which the state of the constitutional health at the time of the solidification of the teeth exerts upon the susceptibility of these organs to morbid impressions, it is only necessary to mention the fact, well known and frequently alluded to, of the early decay of a single

class, or a pair of a single class of teeth, in each jaw, while the rest, possessing the characteristics just described, remain sound through life. Thus, when it happens that a child of excellent constitution is affected with any severe disease, the teeth which are at the time receiving their earthy salts are found, on their eruption, to differ from those which have received their solid material at another time, when the operations of the body were healthfully performed. Instead of having a white, smooth, and uniform surface, they have a sort of chalky aspect, or are faintly tinged with blue, and are rougher and less uniform in their surfaces. Teeth of this description are very susceptible to the action of corrosive agents, and, as a consequence, rarely last long.

Class Second.—Having digressed thus far, we shall now proceed to notice the teeth belonging to the second class. They have a faint, azure-blue appearance; are rather long than short; the incisors are generally thin and narrow, the centrals being frequently a little longer than the laterals. In some cases the lateral incisors are very small and pointed. The cuspids are usually round and pointed; the bicuspids and molars small in circumference, with prominent cusps and protuberances upon their grinding surfaces.

Teeth possessing these characteristics are usually very sensitive, caused, doubtless, by a superabundance of animal matter, and are more easily acted upon than teeth of the first class by corrosive agents, and to the ravages of which, unless great attention is paid to their cleanliness, they often fall early victims. The variety of caries almost peculiar to this class is known as the white, the parts attacked being rendered soft and humid; and as they retain their natural color, it but too frequently happens that such teeth are almost irretrievably ruined before its presence is suspected. They are, also, more frequently affected with atrophy, or have upon their surfaces white, brown, or opaque spots, varying in size and number; several are sometimes found upon a single tooth, and in some instances every tooth in the mouth is more or less marked with them.

But this is not the only description of teeth liable to be affected with this disease. These spots are occasionally met with on teeth of every degree of density, shape, shade, and size; but they are, probably, more frequently seen on teeth of the second class than on those first described; besides which, it often happens that they are affected with erosion on emerging from the gums, and sometimes so badly as to place either their restoration or preservation beyond the reach of art. This species of erosion, or that which occurs previously to the eruption of the teeth, is caused by some diseased condition of the fluid which surrounds them before they appear above the gums, and is denominated congenital.

Teeth like those now under consideration are indicative of a weakly constitution, of a temperament considerably removed from the sanguineous, resembling the lymphatic, and of blood altogether too serous to furnish materials such as are necessary for building up a strong and healthy organism. They are more common to females than to males, though many of the latter have them. They are met with among people of all countries, but more frequently among those who reside in sickly localities, and with individuals whose systems have become enervated by luxurious living.

Class Third.—The teeth of this class, though differing in many of their characteristics from those last described, are, nevertheless, not unlike them in texture and sensibility to disease. They are peculiar to those who have inherited a scrofulous habit or diathesis. In this state of the system we find a sufficient supply of blood, but it is usually of a pernicious character; the whole organism is affected by it and rendered very susceptible to disease, more especially to that class superinduced by cold. Teeth developed under constitutional defects of this nature are larger than teeth of the first or second class; their faces are rough and irregular, with protuberances arising, not only from the grinding surfaces of the biscupids and molars, but also not unfrequently from their sides, with correspondingly deep indentations. They have a muddy white color. The crowns of the incisors of both jaws are broad, long, and thick. The posterior or palatine surfaces of those of the superior maxilla are rough and usually deeply indented. In the majority of cases their arrangement is quite regular, though frequently found to project. The alveolar ridge usually describes a broad arch. The excess in size, both here and in the teeth, seems to consist more of gelatin than calcareous phosphate. Teeth of this description decay rapidly, and in some instances appear to set at defiance the resources of the dentist. They are liable to be attacked at almost every point, but more particularly in their indentations and approximal surfaces. The caries to which these teeth are liable is in color and consistence between the two kinds mentioned in connection with the first and second classes.

The corrosive properties of the fluids of the mouth, however, are sometimes so changed by an amelioration of the constitution that, notwithstanding the great susceptibility of the teeth to disease, they are sometimes preserved to a late period of life, or until the general health relapses into its former or some other unfavorable condition. This has happened in several instances that have come under the author's immediate observation, and it should be borne in mind that the solvent qualities of these secretions are influenced by the state of the constitutional health.

Class Fourth.—Teeth of this class usually have a white, chalky appearance, are unequally developed, and of a very soft texture. They are easily acted upon by corrosive agents, and, like the teeth last noticed, generally fall speedy victims to disease, unless great care is taken to secure their preservation.

Persons who have teeth such as described in this class, generally have what Laforgue has called *lymphatico-serous* temperaments. Their blood is usually pale, the fluids of the mouth abundant, and for the most part exceedingly viscid. They do not have that white, frothy appearance observable in healthy, sanguineous individuals.

As teeth that are neither too large nor too small, and that have a close, compact texture, and tinged with yellow, are indicative of an originally good constitution, whatever it may be at the present time, so those that are long, narrow, and faintly tinged with blue, as well as those that greatly exceed the ordinary size, and that are irregular in shape, and have a rough, muddy appearance, furnish assurance of a constitution originally bad. The first of the latter descriptions of teeth are more frequently met with among females than males, and among those of strumous habit, than those in whom this diathesis does not exist.

Class Fifth.—The teeth belonging to this class are characterized by whiteness and a pearly gloss of the enamel. They are long and usually small in circumference, though sometimes well developed. They are regarded by many as denoting a tendency to phthisis pulmonalis, and are supposed by some to be very durable; but the author has observed that individuals who have this sort of teeth, when attacked by febrile or any other form of disease having a tendency to alter the fluids of the body, are very subject to toothache and caries; and that when this condition of the general system is continued for a considerable length of time, the teeth, one after another, in rapid succession, crumble to pieces.

It would seem, from this circumstance, that the fluids of the mouth in subjects of strumous habit, if free from other morbid tendencies, are less prejudicial to the teeth than they are in most other constitutions, and the author is of the opinion that it is owing to this that they are so seldom attacked by caries.

There are other cases in which the teeth are of so inferior a quality that they no sooner emerge from the gums than they are attacked and destroyed by caries, while the subjects who possess them are enabled, by skillful treatment, to overcome the morbid constitutional tendencies against which, during the earlier years of their existence, they had to contend, and eventually to acquire excellent health. But in forming a prognosis, it is essential to ascertain whether the general

organic derangement which prevented the teeth from being well formed, and thus gave rise to their premature decay, is hereditary, or whether it has been produced by some accidental cause subsequent to birth. The procurement of health in the former case will be less certain than in the latter, for when the original elements of the organism are bad, the attainment of a good constitution is more difficult.

Persons of sanguineo-mucous temperaments, having suffered in early childhood from febrile or inflammatory diseases, often have their teeth affected with what Duval calls the decorticating process (denudation of their enamel), resulting, no doubt, from the destruction of the bond of union between it and the dentine.

There are other characteristics which the teeth present in shape, size, density, and color, and from which valuable inductions might be made, both with regard to the innate constitution and the means necessary to their own preservation; but as the limits assigned to this part of our subject will not admit of their consideration, we shall conclude by observing that the appearances of these organs vary almost to infinity. Each is indicative of the state of the general health at the time of their formation, and of their own physical condition and susceptibility to disease.

CHAPTER II.

DENTITION.

The term "dentition" implies the eruption of the teeth, and is a process which consists of two stages, namely, first dentition and second dentition. At about the seventh week of intra uterine existence the process of development of the teeth of first dentition begins, and shortly after birth the outlines of the forms of the deciduous teeth may be observed on the external aspect of the jaws; but as age advances, owing to the increased development of the mucous membrane and alveolar processes, these outlines become less apparent. As the period of dentition approaches, a slight ridge on the summit of each jaw is seen, which is attributed to the dipping down of the process of epithelium which forms the enamel organ. Prior to the sixth month of age (first dentition commencing generally between the fifth and seventh months after birth), small prominences are observed on the summits of the alveolar processes, which gradually become more distinct and almost as light in color as the teeth themselves. As soon as the tooth has penetrated the mucous membrane, the latter contracts so as to permit the crown of the tooth to project above its level.

The deciduous teeth begin to erupt between the fifth and seventh months, and at the age of two years and a half all of the first set have appeared, the corresponding teeth of the two sides of the jaw erupting at the same time. The two inferior central incisors appear at the age of six or seven months, in the order in which they are named, followed by the superior central incisors, the superior lateral incisors, the inferior lateral incisors, the four first molars, the four canines, and last, the four second molars. The usual order of the eruption of the deciduous teeth is as follows:—

Central incisors	between	the	5th and 8th	months.
Lateral incisors	"	"	7th and 10th	"
First molars	"	"	12th and 16th	"
Cuspids	"	"	14th and 20th	"
Second molars	"	"	20th and 30th	"

The lower teeth generally precede the upper teeth by a few weeks, appearing in the same order.

This order, however, is not invariably followed, for teeth may be prematurely erupted so as to be seen at birth. But the cases of retarded eruption are much more common than those of premature eruption, owing to constitutional debility or the existence of some constitutional disease.

During the eruptive period there is a gradual elongation and protrusion of the teeth, and a coincident dissolving away of both the hard and soft tissues which overlie them. The approximal edges of the alveolar borders of the maxillary bones disappear by an absorptive process, the teeth rise in their cavities, and their roots lengthen to such a degree that the crowns press upon the opposing gums, which, under such pressure, become thinner and thinner, until finally the crowns escape.

Henry Sewell, M.R.C.S., gives the following concise description of the process of eruption: "The eruption of the teeth is a process of gradual elongation of the teeth on the one hand, and the simultaneous absorption of the super-imposed tissue on the other. The absorption commences, first, in the overhanging margins and front walls of the alveoli, which gradually disappear until room is afforded for the passage of the advancing tooth. The growth of the tooth keeps pace with this absorption, and the crown of the tooth at length pressing against the membranous coverings, these undergo atrophy, and becoming by degrees thinner, and at last transparent, give way and disclose the advancing crown."

The exact relation of dentition to infantile diseases is not generally recognized, and many affections have been erroneously ascribed to this process.

There is no doubt, however, that the condition of the system at the period of first dentition is such that the infant is very susceptible to nervous impressions, and hence the symptoms of any constitutional disease that may be present are greatly aggravated.

Owing to the predominance of the nervous system in infancy, there is a greater sympathy between distant organs than in adult life, and considerable disturbances may be excited early in life by even slight functional disorders. The brain is proportionally larger and less perfect in structure than in the adult; the tissues of the body are also softer and more vascular, the skin is more sensitive, the abdomen, glands, kidneys, liver, pancreas, and lacteal vessels are disproportionately large, and functional activity depends chiefly upon the nutritive processes. Such peculiarities, therefore, account for the susceptibility to disease in infants and the tendency of their disease to become inflammatory, and to involve organs not originally affected.

The evolution of the teeth is commonly attended with more or less inflammation of the parts in relation with the dental follicles, and this turgescence is greater with some teeth than with others; sometimes it is present to such a degree that the gums are greatly swollen and extremely tender, presenting a very red appearance, more so than in ordinary dentition.

The indications of the eruption of the teeth are an increased flow of saliva, which tends to keep the mouth moist and cool, and is due to the irritation of the trifacial nerve, which gives sensation to the teeth and nutrition to the salivary glands; an itching of the mouth, which causes the infant to keep its fingers on the gums, as a slight pressure evidently gives some relief; the irritation continuing, the mouth, as a result, becomes hot and dry, and there is more or less febrile excitement. Diarrhea frequently ensues, which, if not too great, is beneficial; one or both cheeks may become unusually red, which is a symptom of nervous disturbance; eruptions may appear on the face or head, and sometimes on the entire body; ulceration may occur on the lips, gums, inside of the cheeks, and on the tongue; itching of the nose, twitching of the muscles, disturbed sleep, wakefulness, dilatation of the pupils, thirst, loss of appetite, all indicate an increase of the irritation; the temper becomes very irritable, and delay in the eruption of a tooth may cause congestion of the gum with swelling of the cheek; nausea and vomiting, diarrhea, fever, thirst, and other systemic disturbances, such as convulsions, etc., may soon succeed these symptoms. A premature eruption of the teeth is more liable to give rise to constitutional symptoms than a tardy or delayed eruption.

The salivary secretion, which is very scanty prior to the period of the eruption of the teeth, always increases as dentition approaches,

and in cases of difficult dentition becomes very profuse. A decided form of stomatitis may be present, and in some cases even abscesses have formed, which could only be relieved by incisions. As a general rule the degree of irritation present depends upon the number of teeth erupting, but, owing to the difference of susceptibility, one tooth may give rise to more irritation than the simultaneous eruption of several teeth will in other cases.

A perfectly healthy child, properly cared for, may erupt its teeth with little or no suffering, although there may be some restlessness, a slight decrease of appetite, and a slight elevation of the temperature of the mouth. At other times a mere local uneasiness may be experienced, which will induce the infant to place its finger in the mouth, or to bite upon some foreign substance, which apparently affords relief. In such cases as these the processes of the development of the teeth, and the absorption of the tissues confining them, are equal, and the result is that the teeth perforate the gum without causing either pain or irritation. Where, however, there is a difference in the progress between the growth of the teeth and the absorption of the opposing structures, then these different forces produce irritation, and a difficult dentition results.

When the eruptive period arrives, the roots of the teeth are yet incomplete, for instead of a conical end and the small opening or foramen which a completed tooth presents, there is a voluminous pulp occupying a cavity with an incomplete termination almost as large as the root itself; hence any considerable increase of vascular and nervous action produces a hyperæmia of the pulp which may cause its protrusion and induce thereby constitutional disturbance.

The immediate cause of the irritation is conceded to be due to the downward pressure of the root upon the nerves and vessels of the pulp of the tooth, such pressure being caused by the opposing gum, and giving rise to congestion and swelling, which have the effect of increasing the induration of the opposing tissues. Constitutional as well as local symptoms result from such irritation, some of which are of the most serious character. The cerebro-spinal system may become affected, giving rise to restlessness, sleeplessness, pain in the head, convulsions, or paralysis; also the respiratory system, a condition which is manifested by cough, catarrh, bronchitis, pneumonia, or spasmodic croup; also the alimentary canal, where there may be nausea, vomiting, loss of appetite, or diarrhea; also the skin may become affected, and such forms of skin disease may manifest themselves as eczema, acne, etc. Therefore, the period of dentition may be a dangerous one, for many infants die at this time, either from convulsions, from whooping cough, or cholera infantum. Difficult dentition is more

frequently a predisposing than a direct cause of infantile convulsions. At such a period a sensitive state of the nervous system, or an afflux of blood to the head, may result in convulsions, although such an affection may be the direct consequence of the irritation caused by the efforts of several teeth to erupt at the same time, especially in the case of weakly children.

The premonitory symptoms of convulsions are depression, restlessness, and fretfulness for some days before the paroxysm; the eyes have a wild, unnatural appearance, the sleep is disturbed, and sometimes there is unusual heat of the head, with a sudden starting or twitching of the limbs. In general convulsions, the paroxysm is characterized by a hot head during its early stage, and a flushed face, while in sympathetic convulsions the head is cool and the face pallid; the pulse is accelerated, as well as the respiration, which is also irregular, especially if the respiratory muscles are involved, which is usually the case. The muscles of the face, eyes and eyelids, and limbs are in a state of rapid involuntary contraction and relaxation; the features are distorted; the mouth is drawn out of shape, and the teeth become tightly closed, owing to the tonic contraction of the masseter muscles; and if the paroxysm is prolonged, frothy saliva may issue from the lips.

The eyelids are usually open, and in severe cases the pupils of the eyes are concealed under the upper lids, or the eyeballs may be forcibly drawn from side to side. The head is strongly retracted, or turned to one side; the thumbs and fingers are convulsively flexed, so that the former are turned across the palms and covered by the fingers; the great toe is adducted and the other toes are flexed, and with the legs move spasmodically; consciousness is lost. The duration of the paroxysm varies from a few minutes to several hours, generally averaging from five to fifteen minutes; and when it terminates favorably, the spasmodic movements gradually cease, and are followed by a deep inspiration and quiet or sleep, with a return of consciousness. The temperature and respiration become natural, although dullness and bewilderment of mind may continue for several hours. In severe cases, the respiration is so embarrassed and the circulation so retarded that congestion of various organs results. Death does not usually occur from one paroxysm, but from several at intervals, during the last of which convulsive movements cease, and there is no return of consciousness; the limbs grow cold, the pulse feeble, and coma supervenes.

The treatment of convulsions consists in first removing the irritation by the use of the gum-lancet, by emesis, purgatives, etc., according to the indications; the feet, as soon as possible, may be put in hot water,

to which mustard is added; or a warm bath may be used; such measures have a soothing effect upon the nervous system, and cause muscular relaxation and derivation of blood from the cerebro-spinal axis. They also prevent passive congestion and edema of the brain and lungs. Antispasmodics and nervous sedatives are indicated after the cause of the irritation has been removed. Cool applications, in the form of a cloth frequently wrung out in cold water, should be made to the head, to reduce its temperature, which will have the effect of contracting the vessels and membranes of the head, and diminishing the cerebral congestion. An aperient is useful, unless there has been previous diarrhea. An enema of soap and water will produce free and speedy evacuation, as it is often necessary to relieve the digestive canal of irritating substances.

For the relief of the paroxysm, and to lessen its duration, chloroform has been successfully employed as an anesthetic, but as it is a dangerous agent, the bromid of potassium is preferable, in doses of three grains for a child one year of age, or four or five grains for a child of two or three years of age, dissolved in cold water, and administered every ten minutes; after the convulsions cease, there should be longer intervals between the doses. In very severe cases, where the bromid of potassium may not act with the required promptness, the hydrate of chloral may be employed in doses of five grains for a child of one year of age, and ten grains for one of four years of age, dissolved in two or three drachms of water, and injected, by means of a small syringe, into the rectum. The bromid of potassium may be combined with the chloral as follows: ℞. Potassii bromid. gr. xvj; Chloral. hydrat. gr. iv to vj; Sodii bicarb. gr. xv; Aquæ menth. pip. f℥j. M.

This remedy is generally successful in controlling the spasmodic movements in five or ten minutes, unless recovery is impossible. During such premonitory symptoms of difficult dentition as fretfulness and nervous excitement, the bromid of potassium is a useful and safe remedy. Demulcent and soothing lotions are useful to reduce the swelling and tenderness of the gums; and an ivory or rubber ring, for the child to bite upon, will afford great relief.

The practice of rubbing the gums with a thimble or ring is injurious, as the swelling and tenderness are increased.

Unless the tooth is on the point of protruding, the operation of lancing the gum is by many thought to be unnecessary, for the reason that the gum is not rendered tense by the pressure of the advancing tooth, and too much importance has been attached to the supposed tension and resistance of the gum.

When the symptoms are local and the gums are somewhat congested

and swollen, scarifying them lightly with a very sharp lancet will often afford relief; but if the gums are very tender this operation should not be performed.

Others, again, advocate the operation of lancing the gums in difficult dentition, even when no single local indication exists in the mouth, by making free incisions over the teeth whose eruption is anticipated, the cuts extending through the gum to the presenting surface of the tooth, and thus affording manifest and complete relief. No injury results to the erupting tooth, or to the germ of the developing permanent one, if the lancet is carried to the surface of the crown, without undue force is employed. Partially erupted canines and molars sometimes require the use of the lancet to relieve the pressure of the enclosing band of gum tissue. Such objections against lancing the gums, as the infliction of great pain and uncontrollable hemorrhage, are of little moment, as is also the assumed increased

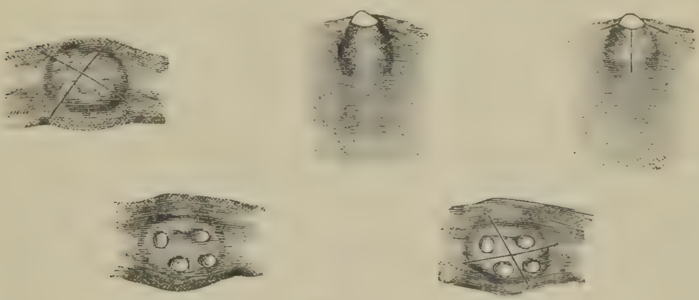


FIG. 114.

resistance of cicatricial tissue; for, although the wound made by the lancet should heal before the appearance of the tooth, this cicatricial tissue is easier absorbed, and consequently less resistant.

For lancing the gum over an incisor, a single incision in the line of the arch will answer; the molars generally require a crucial incision, and the gum of the canines, even after the point of the cusp has emerged, may require severance on the lateral, anterior, and posterior surfaces, in order to relieve the tension and liberate these teeth. The illustrations (Fig. 114) show the necessary incisions for the different classes of teeth. Should undue bleeding result from such an operation, it can be arrested by means of a little finely powdered alum applied to the incisions; should such a remedy fail, more powerful astringents or styptics can be employed, such as tannic acid, styptic colloid, matico, powdered resin, etc. Nitrate of silver and the iron preparations are liable to cause slough and secondary hemorrhage; hence should never be employed in such cases. As the act of

sucking the gums may promote persistent bleeding, in such cases the child should be either placed at the breast of the nurse, or a gag of soft linen be introduced in such a manner as will prevent the infant from sucking its gums. Internal remedies in case of a hemorrhagic diathesis are indicated to correct an abnormal or depraved condition of the blood and promote contraction of the orifices of the bleeding vessels; but their use is seldom necessary.

When such remedies are indicated, tincture of the muriate of iron, acetate of lead, aromatic sulphuric acid, gallic acid, and turpentine are the agents to be employed. Dr. James W. White gives the following formula which will meet all the indications in such cases:—

℞. Tinct. ferri chloridi,	f ʒ ss.	
Acid. acetic. dil.,	f ʒ j.	
Liq. ammonii acet.,	f ʒ j.	
Ext. ergot. fld.,	f ʒ ij.	
Syr. simp.,	f ℥ ss.	
Aquæ, q. s. ad	f ℥ iij.	M.

Dose, a teaspoonful every three hours for a child six months old.

It is not unusual for some children to be affected with diarrhea during the period of dentition, and which may be accompanied with irritability of the stomach. Where not too debilitating and protracted, the diarrhea is beneficial, but, on the other hand, it must not be neglected and permitted to become a source of danger. But there are often other causes for this affection than those which can be attributed to dentition, such as improper food and clothing, residence in unhealthy localities, and exposure to cold.

The diarrhea, when severe, should be controlled by proper remedies, capable of reducing the number of evacuations to two or three daily, as a greater number may result in danger to the child. The treatment of the diarrhea of dentition consists in a change in the diet, the adoption of hygienic measures, and, when medicines are necessary, the administration of the milder purgatives in small doses. Where the dejections are acid, as is shown by the green color, half a teaspoonful to one teaspoonful of castor oil or calcined magnesia will prove beneficial. According to Dr. West, if there be neither much pain nor tenesmus, and the evacuations, though watery, are fecal, and contain little mucus and no blood, very small doses of the sulphate of magnesia and tincture of rhubarb are more useful than any other remedy.

℞. Magnesia sulphatis,	ʒ j.	
Tinct. rhei,	ʒ j.	
Syr. zingiberis,	ʒ j.	
Aquæ carui,	ʒ ix.	M.

SIG.—One dram three times a day, for children one year old.

Dr. Christopher Elliott recommends half to one dram doses of the infusion of chamomile-flowers for infantile diarrhea of dentition, when the evacuations are greenish in color or are slimy and streaked with blood.

For the diarrhea of infants due to indigestion, and attended with acidity, Professor J. L. Smith recommends the following :—

℞.	Pulv. ipecac., ...	gr. ss.	
	Pulv. rhei, ...	gr. ij.	
	Sodæ bicarb., ...	gr. xij.	M.

Divide into chart No. xij. One powder every four to six hours, for an infant one year old.

The same author also recommends the following in the non-inflammatory diarrhea of infants :—

℞.	Tinct. opii deodorat., ...	gtt. xvj.	
	Bismuth. subnitrat., ...	ʒ ij.	
	Syr. simplic., ...	℥ ss.	
	Mistur. cretæ., ...	ʒ iss.	M.

Shake well, and give one teaspoonful from three to four hours.

For increased excitability of the intestine due to dental irritation, which is indicated by frequent stools of semi-solid matter containing undigested food, Dr. Lees recommends the use of bromid of potassium in from three to five-grain doses every three or four hours for a child one year of age. Persistent constipation may be treated with ten-drop doses, three times daily, of cod-liver oil, increasing the dose if necessary to a half dram.

For the skin affection attending dentition, such as eczema in the acute form, with a watery discharge and an irritable skin, oxid of zinc, used as a dusting powder, will prove serviceable, but the parts should not be washed with water.

When the discharge is thicker and more purulent, and forms scabs, they may be removed by bathing the part with oil and washing it with soap and water, and a salve applied, composed of equal parts of vaseline and simple lead plaster ; or less of the lead plaster may be used with the vaseline, if the salve should prove too strong ; or an ointment may be employed, composed of oxid of zinc, five grains, and simple salve, one ounce.

When the gum over an erupting tooth appears swollen and congested, and at length ulcerates, even after the tooth is protruding, a condition to which the appellation "odontitis infantum" has been applied, the ulcers may be touched with a crystal of alum, and a lotion composed of sage tea and honey used, with decided advantage. For a sloughing condition of the mucous membrane over an

erupting tooth, the careful application of strong carbolic acid will prove efficient.

During infancy, and especially during the period of dentition, the clothing should consist of fine, soft flannel next to the skin, to protect the body from variations of temperature, and all changes be made gradually. The food for some months after birth should be confined exclusively to milk, that of the mother being preferable when she is in good health. For artificial food, when such is necessary, an excellent preparation is that of Dr. J. F. Meigs, which consists of equal parts of milk, cream, lime-water, and oatmeal, barley- or arrowroot-water, to which a little sugar of milk is added.

SECOND DENTITION.

The design of nature is to preserve the deciduous teeth until their roots are absorbed and they become loose, and are removed to make room for their permanent successors. But the eruption of the permanent teeth begins before any of the deciduous teeth are removed. Between the ages of five and a half and six years, the first permanent molars make their appearance; hence they are commonly called "sixth-year molars," and their germs, with those of the remaining permanent teeth, are progressing with the development of the deciduous teeth.

When the permanent teeth are developing, and their crowns, on account of the growth of the roots, are approaching the alveoli of the deciduous teeth, a process of absorption, decalcification, commences, by which the roots of the latter teeth are gradually destroyed, the dissolving process going on until only the crowns of the deciduous ones remain. The process of absorption affects the roots of the deciduous teeth in the order corresponding to their development and eruption; the inferior central incisors are first shed, then the superior central incisors, then the lateral incisors; and this order is preserved until all of the deciduous teeth have been removed or have become so loose that they are easily extracted.

The absorptive process commences in the alveoli of the deciduous teeth, and then attacks the apices of their roots, and in some cases progresses until it involves a large portion of the crowns. The loss of substance commences generally upon the side of the root, near the apex, toward the advancing crown of the permanent tooth, and the surface of the root acted upon presents pits, grooves, or irregular facets, with rough surfaces and sharp edges, such as would result from corrosion. If a deciduous tooth undergoing this process of absorption be extracted, a loose, spongy substance is found adherent to it, which Laforgue and Bourdet supposed to be an

absorbent organ—vascular papilla—secreting a fluid capable of dissolving the tooth-structure. According to Wedl, a fluid is secreted by the cells of this organ which dissolves the hard substance, and referring to the theory held by some, he says "that these cells are of a parasitic nature, that is to say, that the dental substances are eaten up, as it were, since the cells absorb the latter, and he remarks that "possibly ameboid movements may be the occasion of the wasting of the tissues;" he is also of the opinion that the organ of absorption is developed from the connective tissue of the root membrane of the deciduous tooth. According to a microscopic examination made by Mr. Tomes, the surface of this absorptive organ is made up of peculiar multiform cells, each one being composed of several smaller

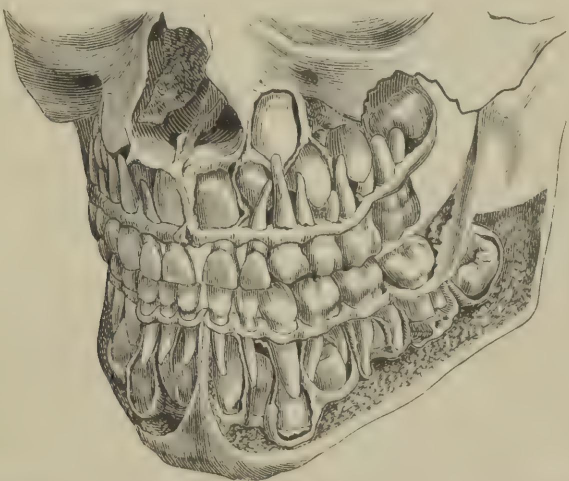


FIG. 115.—ILLUSTRATES THE JAWS OF A CHILD BETWEEN SIX AND SEVEN YEARS OF AGE SHOWING THE RELATIONS OF THE TWO SETS OF TEETH.

cells, the number varying from two to three to as many as fourteen or fifteen.

Some have regarded the method employed by nature for the removal of the roots of the temporary teeth as *sui generis*, but there is a better reason for considering it to be the effect of an inflammatory process that brings about a proliferation of cell-growth, which may at one time act as an absorbent and at another be reparative. As to the precise manner in which these cells of the absorbent organ act, much remains to be learned, but that it is a physiological process, and occasioned by the action of cells known as "osteoclasts," or "odontoclasts," and is not a mechanical force, is now quite generally admitted. These cells secrete what has been termed "a soluble

ferment," or "fluid of exudation," which dissolves out the lime salts from the hard tissues with which it comes in contact, the surface acted upon presenting a series of pits and cup-shaped depressions.

Dr. C. N. Pierce, in an excellent article, entitled "Calcification and Decalcification of the Teeth,"* and which is illustrated by the following instructive figures (Fig. 116), in treating of the absorption or decalcification of the roots of the deciduous teeth, regards this process "as being both physiological and somewhat obscure," and he further states:—

"The evidence that it is the result of a physiological action is the fact that it matters not to what extent absorption has progressed, the very moment vitality of the pulp ceases that instant this retrograde metamorphosis terminates. What induces this molecular dissolution it is difficult to state, though the several conditions which are always present are readily recognized; but the part they play is so obscure that it is not readily ascertained. The manner of its commencement when successful—always at the end of the root—and the presence of a vascular papilla in close proximity to the absorbing surface, are, with the retention of pulp vitality, three essential accompaniments, and the absence of any one of them would militate against the completion of the process.

"The statement that the presence and pressure of the permanent tooth are essential, cannot be sustained, for frequently the decalcification of the deciduous tooth is successfully accomplished in the absence of its successor; and again, how often do we find the permanent tooth impacted against or within the bifurcated roots of the deciduous molar, or pressing down by the side of its single-rooted predecessor, both being more or less displaced by the persistence of the deciduous tooth without absorption. That the organ has served its purpose, and that the nourishment which had previously been appropriated by it is diverted or relegated to its successors, is probably the most plausible explanation we can give of this interesting physiological process."

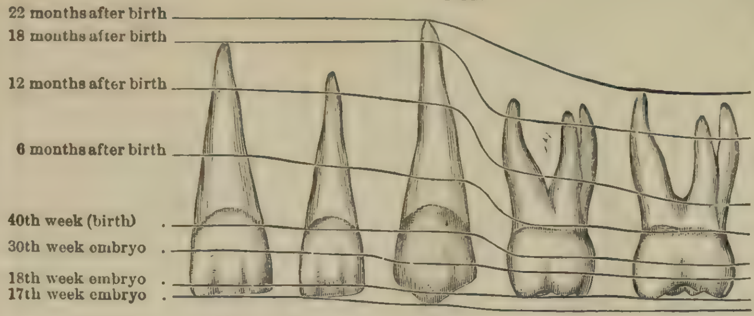
The average time and order for the eruption of the permanent teeth are as follows:—

First molars, ...	5 to 6 years.
Central incisors, ...	6 " 8 "
Lateral incisors, ...	7 " 9 "
First bicuspids, ...	9 " 10 "
Second bicuspids, ...	10 " 12 "
Canines, ...	11 " 13 "
Second molars, ...	12 " 14 "
Third molars, or wisdom teeth, ...	17 " 21 "

* *Dental Cosmos*, August, 1884.

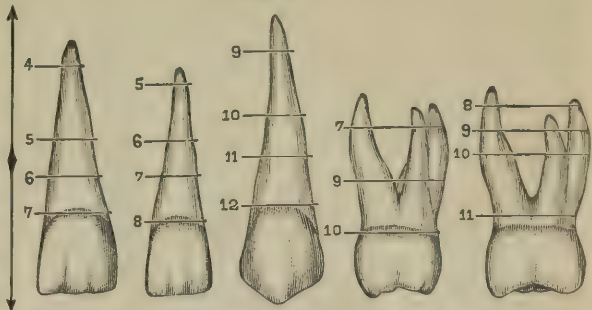
CALCIFICATION AND DECALCIFICATION OF THE TEETH.

Fig. 1.



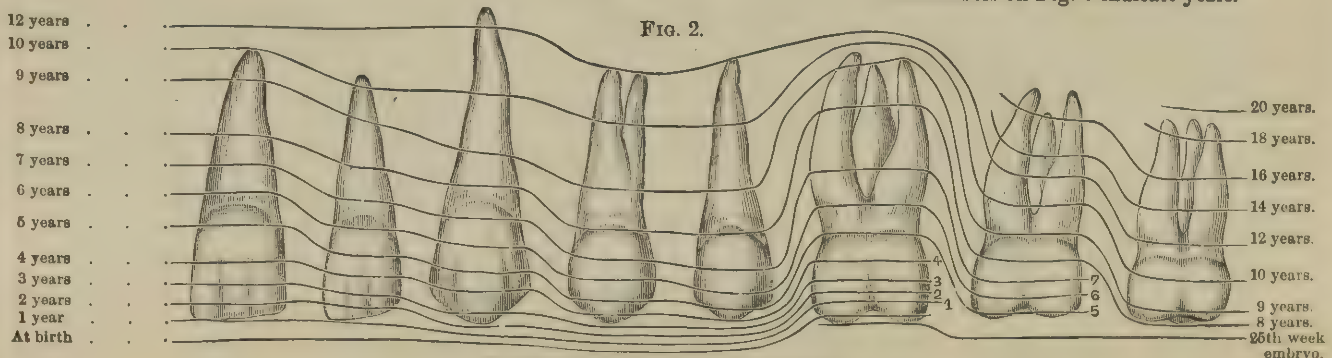
Calcification of the Deciduous Teeth.

Fig. 3.



Decalcification of the Deciduous Teeth.
The numbers on Fig. 3 indicate years.

Fig. 2.



Calcification of the Permanent Teeth.

From a Paper by Dr. C. N. Peirce, in the Dental Cosmos for August, 1884.

Fig. 116.

Usually little or no difficulty attends the eruption of the permanent teeth, with the exception of the third molars of the lower jaw, which may cause considerable trouble and suffering, on account of their being crowded between the second molar and the ramus or ascending portion of the jaw, the space left being insufficient to accommodate the third molar. Inflammation from such a cause may extend to the soft tissues, such as the muscles, and render the act of swallowing difficult and painful, and that of mastication impossible. The inflammation thus caused may also terminate in suppuration, and the pus discharge at remote points, internal or external. Such maladies as neuralgia, hysteria, epilepsy, St. Vitus' dance, disordered vision, earache, deafness, tetanus, etc., have been caused by the eruption of the third molar. Occasionally the eruption of the molars anterior to the third molars may be attended with some constitutional disturbance, such as headache, slight neuralgic pains, impaired appetite; and also local symptoms, such as swollen gums, increased heat of mouth, and an increased flow of saliva. The extraction of the third molar may be necessary in some cases; in others, that of the second molar, although the removal of a carious first molar may sometimes relieve the crowded condition of the arch, when the trouble is owing to a want of space between the second molar and the ramus of the jaw. The lancing of the gum over a third molar not yet protruded often relieves. The most common period of suffering from second dentition, apart from that of the third molar, is from the tenth to the thirteenth year, and it is characterized by such affections as obstinate and protracted cough, with paroxysms of long duration, also diarrhea, wasting of flesh, nervous diseases, loss of spirits, headache, and morbidly sensitive and painful eyes.

The obstinate cough disappeared when the molar teeth pierced the gums; and a mixture of iron and nitric acid was successful in immediately curing a patient of seven years of age in the practice of Dr. James Jackson, who recommends the following remedies as being most useful:—

"First, a relief from study or from regular tasks, yet using books so far as they afford agreeable occupation or amusement. Second, exercise in the open air, preferring the mode most agreeable to the patient, and in more grave cases the removal from town to country."

Fig. 117 represents an instrument, the invention of Mr. Woodhouse, and introduced by Dr. L. D. Shepard, designed for the removal of the overlying gum which covers the masticating surfaces of the first and third molars very often for months after the cusps have appeared through the gum, and thus promotes, if it does not cause, the decay so frequently attacking these teeth upon their eruption. An incision

is made with a lancet, through the gum, along the anterior margin of the tooth, and the thin, flat blade of the cutter is inserted; then, by closing the handles, the section of gum the size of the blade is instantly removed. The operator will find this process much more effectual, and far easier to the patient, than the usual practice of cutting the gum in different directions.

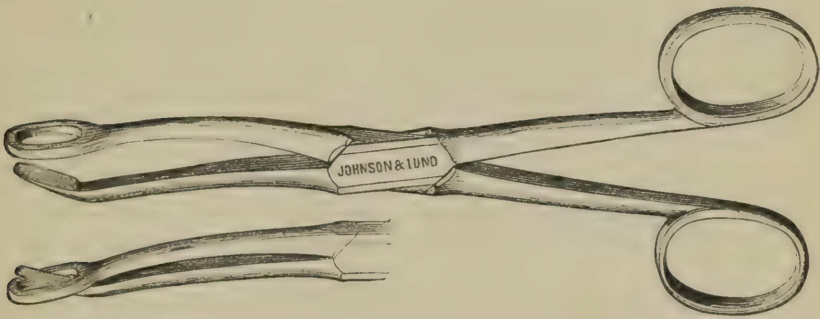


FIG. 117.

THIRD DENTITION.

That nature sometimes makes an effort to produce a third set of teeth is a fact which, however much it may be disputed, is now so well established that no room is left for cavil or doubt.

The following interesting particulars are taken from "Good's Study of Medicine:"—

"We sometimes, though rarely, meet with playful attempts on the part of nature to reproduce teeth at a very late period of life, and after the permanent teeth have been lost by accident or by natural decay.

"This most commonly takes place between the sixty-third and eighty-first year, or the interval which fills up the two grand climacteric years of the Greek physiologist, at which period the constitution appears occasionally to make an effort to repair other defects than lost teeth. . . .

"For the most part, the teeth, in this case, shoot forth irregularly, few in number, and without proper roots, and, even where roots are produced, without a renewal of sockets. Hence, they are often loose, and frequently more injurious than useful, by interfering with the uniform line of indurated and callous gums, which, for many years, perhaps, had been employed as a substitute for the teeth. A case of this kind is related by Dr. Bisset, of Knayton, in which the patient, a female in her ninety-eighth year, cut twelve molar teeth, mostly

in the lower jaw, four of which were thrown out soon afterward, while the rest, at the time of examination, were found more or less loose.

"The German Ephemerides contain numerous examples of the same kind; in some of which teeth were produced at the advanced age of ninety, a hundred, and even a hundred and twenty years. One of the most singular instances on record is that given by Dr. Slade, which occurred to his father, who, at the age of seventy-five, reproduced an incisor, lost twenty-five years before, so that, at eighty, he had hereby a perfect row of teeth in both jaws. At eighty-two they all dropped out successively; two years afterward they were all successively renewed, so that at eighty-five he had once more an entire set. His hair, at the same time, changed from a white to a dark hue; and his constitution seemed, in some degree, more healthy and vigorous. He died suddenly, at the age of ninety or a hundred.

"Sometimes these teeth are produced with wonderful rapidity; but in such cases with very great pain, from the callosity of the gums through which they have to force themselves. The Edinburgh Medical Commentaries supply us with an instance of this kind. The individual was in his sixty-first year, and altogether toothless. At this time his gums and jawbones became painful, and the pain was at length excruciating. But within the space of twenty-one days from its commencement, both jaws were furnished with a new set of teeth, complete in number."

A late physician of Baltimore informed the author, in 1838, that an example of third dentition had come under his own observation. The subject, a female, at the age of sixty, he assured him, erupted an entire new set in each jaw.

The following extract of a letter from a professional friend* describes another very interesting case:—

"I have just seen a case of third dentition. The subject of this 'playful freak of nature,' as Dr. Good styles it, is a gentleman residing in the neighborhood of Coleman's Mill, Caroline County, Virginia. He is now in his seventy-eighth year, and, as he playfully remarked, 'is just cutting his teeth.' There are eleven out, five in the upper and six in the lower jaw. Those in the upper jaw are two central incisors, one lateral and two bicuspids, on the right side. Those in the lower are the four incisors, one cuspid and one molar. Their appearance is that of bone, extremely rough, without any coating or enamel, and of a dingy brown color."

* Dr. J. D. McCabe.

Two cases somewhat like the foregoing have come under the author's observation. The subject of the first was a shoemaker, Mr. M., of Baltimore, who erupted a lateral incisor and cuspid at the age of thirty. Two years before this time he had been badly salivated, and, in consequence, lost four upper incisors and one cuspid. The alveoli of these teeth exfoliated, and at the time he first saw him were entirely detached from the jaw, and barely retained in the mouth by their adhesion to the gums. On removing them, he found two white bony protuberances, which, on examination, proved to be the crowns of an incisor and cuspid. They were perfectly formed, and though much shorter than the other teeth, yet up to 1845 they remained quite firm in the jaw.

The subject of the other case was a lady residing near Fredericksburg, Virginia, who erupted four right central incisors of the upper jaw successively. One of her temporary teeth, in the first instance, had been permitted to remain too long in the mouth, and a permanent central incisor, in consequence, came out in front of the dental arch. To remedy this deformity, the deciduous incisor was, after some delay, removed; and about two years after, the permanent tooth, not having fallen back into its proper place, was also extracted. Another two years having elapsed, another tooth came out in the same place and in the same manner, and, for similar reasons, was also removed. To the astonishment of the lady and her friends, a fourth incisor made its appearance in the same place, two years and a half after the extraction of the first permanent tooth. When it had been out about eighteen months, the author was called in by the lady, who wished him, if possible, to adjust it. Finding that it could not be brought within the dental circle, he advised her to have it extracted and an artificial tooth placed in the proper place in the arch.

In the second number of the eighth volume of the *American Journal of Dental Science*, the history of a case of four successive dentitions of the upper central incisors is given.*

The following interesting case is related by Dr. B. H. Catching in the *Southern Dental Journal* for October, 1886. The patient was a girl, born August 6, 1871, very small and delicate, having been a six-months' child.

At the age of six months the eruption of the teeth began, and at seven months she possessed a full set of diminutive teeth, all of which were shed within three months. When eleven months old, teeth again began to erupt, and at the age of fifteen months a second full set was in her mouth. These soon crumbled away, and her mouth was with-

* Dr. W. H. Dwinelle.

out teeth until she had arrived at the age of two and a half years, when a third set began to erupt. The child weighed at this time but ten pounds, and this third set of teeth caused her so much trouble that the mother endeavored to have them extracted, and not being able to induce a dentist to perform the operation, she extracted twelve of the teeth herself in order to give relief to her child; and all of the third set were removed prior to her fourth year of age. She remained without teeth until her eleventh year, when her last and permanent set began to erupt, nearly all of which were, at the date of writing this account, in her mouth, sound and firm. Her last set is deficient in one superior central incisor, one superior left bicuspid, two inferior right bicuspids, and an inferior left cuspid and bicuspid. At seven years of age this child weighed but thirty pounds, but at fifteen years of age she had developed into a stout, strong girl. Dr. T. T. Moore, of S. C., verifies this case, as the child was under his care also, both himself and Dr. Catching having carefully observed the conditions and development from the beginning to the end.

Concerning the manner of the origin and formation of teeth of third dentition, adopting Wedl's views, germs may lie dormant for many years in the animal organism, until they are subjected to favorable conditions which enable them to develop. The crowns of such teeth only being formed, while the roots are stunted, is clearly due to the small depth of the jaws in old age.

CHAPTER III.

DISEASES OF THE ORAL MUCOUS MEMBRANE.

STOMATITIS.

THE diseases of the mucous membrane lining the mouth, very common at the periods for the eruption of the teeth and later in life, are comparatively rare during fetal life, and differ, as regards symptoms, in accordance with the nature of the affection and the part of the mucous surface in which it may have its origin.

The most common affection of the membrane lining the mouth is known by the general term *stomatitis*, from the Greek word στομα, "mouth," and *itis*, a "suffix denoting inflammation," and is described by Prof. Wood as follows:—

"Inflammation of the mouth appears in reddened, somewhat elevated patches, or occupies large portions of the surface, sometimes extending

apparently over the whole mouth. In some cases it is superficial, with little or no swelling, and may be designated as *erythematous*, from the Greek word ερυθρος, 'red;' in others it occupies the whole thickness of the membrane, extending sometimes to the submucous tissue, and even to the neighboring structures, as the sublingual and submaxillary glands, and the absorbent glands of the neck, and occasions considerable tumefaction in all these parts. In the erythematous form it is characterized by redness and sense of heat, and sometimes considerable tenderness, but is not usually attended with acute pain; when deeper in the tissue it is often very painful.

"Portions of the epithelium sometimes become opaque, giving an appearance of whiteness in streaks or patches. Occasionally this coating is elevated in blisters, or even detached, like the cuticle from the skin in scales. Superficial ulcerations not unfrequently occur, which may spread over considerable portions of the membrane. In certain states of the constitution the ulcerative tendency is very strong and deep, and extensive sores occur, which are sometimes attended with gangrene.

"There is often a copious flow of saliva; though, in some instances, this secretion, as well as that of the mucous follicles, is checked, and the mouth is clammy or dry. The sense of taste is usually more or less impaired, and speech and mastication are often difficult and painful. When the tongue is affected, its surface is, in general, first covered with a whitish fur, through which the red and swollen follicles may often be seen projecting. This fur sometimes breaks off, leaving the surface red, smooth, and glossy, with here and there prominent follicles; or the surface may be hard, dry, or gashed with painful fissures. When the gums are involved, they swell, and rise up between the teeth, around the necks of which they frequently ulcerate. In some cases this ulceration does not cease until it has extended into the sockets, and destroyed altogether the connections of the teeth, which become loosened and fall out, after which the gums will heal.

"Ordinary inflammation of the mouth is seldom so violent as to induce symptomatic fever. This form of inflammation is more frequently a complication of other diseases than an original affection. When of the latter character, it is generally caused by the direct action of irritant bodies, as by scalding drinks, acrid or corrosive substances taken into the mouth, or unhealthy secretions from decayed teeth. The sharp edge of a broken tooth sometimes gives rise to much inflammation, and even deep and obstinate ulcers, especially of the tongue. Inflammation of the mouth may also result from the reaction which follows the long contact of very cold substances, such as ice, with the interior of the mouth. It sometimes proceeds from the propa-

gation of inflammation from the fauces, and is a frequent consequence of gastric irritation produced by sour or acrid matter in the stomach. Drunkards seem peculiarly predisposed to it. Of the constitutional causes none are so frequent as the state of fever, which, whatever may be its peculiar character, is very apt to affect the mouth, and not infrequently occasions inflammation."

Catarrhal Stomatitis.—Catarrhal stomatitis may be either acute or chronic, and a simple form is common to children under the age of one year; while this simple form gives rise in itself to no severe symptoms, yet it may be connected with other serious maladies, and hence is often overlooked. Acute catarrhal stomatitis first appears in the form of bright-red patches at the angles of the mouth and on the inside of the cheeks, which increase in size and sometimes unite, when the entire mucous surface of the mouth may become inflamed. While it is more intense in one part than in another, it may be confined to the tongue alone, or be universally diffused over the whole mucous membrane of the mouth. It is characterized by an increase of the heat and redness of the part affected, rapid proliferation and exfoliation of epithelial cells, and more or less dryness of the surface, as there is but little mucus secreted, with a high degree of sensibility, and pain when the lips or tongue are moved. The pain is of a smarting, burning character, the result of irritation on a denuded surface. Owing to the limited extent of connective tissue, the swelling of the inflamed mucous membrane is generally slight. In severe cases the gums become swollen and spongy, and bleed readily, and the entire surface of the mouth and tongue is covered with a white, viscid mucus; there is an increased flow of saliva, that is acrid and irritating, which may dribble from the corners of the mouth, causing a greater degree of congestion, which is apparent by the dark red color of the affected membrane. A fetid condition of the breath is not common to the acute form of catarrhal stomatitis unless shallow ulcers are present, which result from the rapid loss of the superficial cells and a failure in the development of others to supply their places. The engorgement of the vessels of the mucous membrane is followed by the exudation of white blood-corpsucles.

The intensity of this affection varies in different cases, sometimes existing in such a slight form as to cause little uneasiness, and quietly disappearing, while at other times it may cause intense pain, and continue for weeks or months.

In a severe form it may extend to the esophagus and stomach, or the larynx and trachea, and at last prove fatal, especially if there is present a decided state of cachexia, or a severe co-existing disease.

When it occurs during the period of dentition, to which it is com-

mon, it is often accompanied with fever, and sometimes, especially when long continued, by a profuse flow of saliva; occurring previous to dentition, it is seldom accompanied with fever.

When caused by some disease coincident with the period of dentition, the gum over the erupting tooth becomes inflamed, and the inflammation may extend over the entire buccal surface. But when due to the irritation of dentition, this form of stomatitis is generally more circumscribed than when it arises from a constitutional cause. It may also result from a mercurial course of treatment, exposure to cold, hot and stimulating food, or a diseased condition of the alimentary canal.

In adults catarrhal stomatitis may result from long-continued irritation of the mucous membrane of the mouth, or from injuries to the gums, such as may result from laceration in the extraction of teeth; also from the sharp edges of fractured teeth and roots, and constitutional derangement.

In very young children, among the early symptoms are restlessness and fretfulness, with refusal to take food, or, when attempting to do so, suddenly ceasing on account of the pain experienced.

Chronic catarrhal stomatitis is characterized by the structural changes which ensue on account of the stroma becoming affected. The mucous surface affected becomes indurated and thickened, the mucous glands are obstructed, and, as a result of their secretion being arrested, they become encysted and present a granular appearance on the surface of the membrane. The breath is more or less fetid, owing to the secretions of the mouth becoming vitiated, and the teeth are coated with sordes. The papillæ of the tongue become hypertrophied, but the substance beneath is less affected than in the acute form of this affection. The duration of the acute form is from three to six days, as a general rule, while the chronic form is more persistent.

Simple stomatitis of children is readily relieved by means of emollient washes, such as solutions made from the slippery elm bark or the pith of sassafras, in cold water. When severe, a leech or two applied to the angle of the jaws will prove serviceable, and as a wash, the acetate of lead, in a solution composed of three grains to one fluidounce of water. A few doses of bromid of potassium may relieve the nervous excitement and fretfulness. One part of borax to three of honey, or a dram of borax to an ounce of glycerin and water, or a weak solution of alum, may prove useful local remedies.

The treatment of catarrhal stomatitis consists in first removing the cause of irritation, when such is present, and the use of alkaline washes, or, in more obstinate cases, a solution of either chlorid of

zinc or nitrate of silver, one grain to the ounce of water. Phenol sodique or phenate of soda will correct the fetor of the breath, when used in the form of spray. For the chronic form the following may be applied to the inflamed mucous surface, either in the form of a gargle or spray:—

℞.	Acidi carbolici,	ℨj.	
	Olei gaultheriæ,	ℨij.	
	Glycerini,	ℨij.	
	Olei menthæ piperitæ,	ℨiij.	M.

When the inflammation of the mouth is symptomatic of a diseased condition of the alimentary canal, the remedies adapted to such a condition are necessary.

Ulcerous Stomatitis, also known as "Noma," is another affection of the mouth which is common to childhood, the premonitory symptoms being the same as in simple stomatitis. The inflammation usually begins upon the gums and extends along the buccal surface. An examination of the mouth, however, at this stage of the disease, reveals one or more small, inflamed, and slightly elevated points or pimples, which, sometimes within a few hours, but more commonly after one or two days, present a softened and yellowish apex, and at length a small ulcer, superficial at first, but gradually becoming deeply excavated, with often an inflamed and elevated margin. The surfaces of these ulcers are covered with an ash-colored or a yellowish matter, in the majority of cases; but sometimes, instead of being thus covered, their surfaces are bare, and bleed readily.

Some of the ulcers may unite and form large, irregular ulcerations, while others remain isolated. The ulceration, when severe, gives rise to considerable swelling, especially around the ulcers, and the swollen part is soft, and not very tender on pressure. The soft, yielding nature of the swelling enables this form to be distinguished from gangrenous ulceration, as there is more induration in the latter affection. These ulcers result from acute phlegmonous inflammation, and may attack any part of the mucous membrane lining the mouth, but are most commonly found on the sides of the frenum, along the inferior margin and edges of the tongue, and inside the lips.

It is but seldom that they are found on the upper surface of the tongue; but when they do appear on this surface, they are generally superficial, and not deeply excavated.

When the ulcers in this form of stomatitis are fully formed, there is usually a profuse flow of saliva and a decrease of the febrile excitement. The bowels, which in the first stage of the disease are costive, now become loose, and often very much so during its con-

tinuance. A simple form of ulcerous stomatitis is characterized by but one or two small ulcers, which in a little time fill up with granulations and soon heal over. In a more severe form of this disease a considerable number of these ulcers exist, in some cases covering almost the whole of the mucous membrane of the gums, the inside of the cheeks, arch of the palate, sides and inferior surface of the tongue.

During the early stage of ulcerous stomatitis the mouth becomes hot and painful and the submaxillary glands swollen and tender. The breath becomes very offensive as soon as the ulceration is well established, and there is a tendency to keep the mouth open.

Another form of this disease is sometimes met with where but one or two ulcers exist, but which gradually extend over the mucous surface, at the same time increasing in depth, and with no appearance of healing. This form of the affection is attended with hectic fever, the exacerbations occurring night and morning, and rapidly wearing away the strength.

There is yet another form of ulcerous stomatitis occasionally met with, which consists of a softening of the mucous membrane of the palate in its centre, either on the median line or outside this line. The membrane appears to be softened into a kind of pulp, of a red or fawn color, which, on its removal, discloses an ulcer with perpendicular walls; the bone, however, forming its base is found to be perfectly healthy. It is the opinion of some that ulcerous stomatitis is contagious; that is, that it may be communicated by using the same spoon in eating, and also that it is endemic and epidemic. Ulcerous stomatitis is common to the period of dentition, especially when there is disorder of the digestive organs.

The causes of ulcerous stomatitis are uncleanliness, poor food, residence in damp, dirty places, mercury, a cachectic condition, enfeebled system, and contagion.

The treatment of ulcerous stomatitis consists in a change of residence and diet, cleanliness, the use of tonics, ferruginous or vegetable, such as the liquor ferri nitratis, with tincture of calumba, given in simple syrup, tincture of chlorid of iron, and sulphate of quinin, or cod-liver oil, and such local remedies as dilute chlorid of zinc, carbolic acid, nitrate of silver, muriatic acid, with an alternate wash of honey and borax, equal parts; or the chlorid of lime applied dry to the ulcerated surface twice daily, and simple water used during the interval, and continued until a healthy appearance is apparent, when a weak solution of chlorid of lime, one grain to forty-five of water, is employed. Chlorid of lime one dram, with honey one ounce, is also recommended. Chlorate of potassium often

acts like a specific, employed internally and externally, the dose of which is two or three grains, dissolved in water with sugar, or in syrup.

The following formula may be employed :—

℞.	Potass. chlorate,	ʒss to j.	
	Mellis,	℥ss.	
	Aquæ,	℥ij.	M.

One teaspoonful every two hours, and also applied as a lotion.

Dr. Condie recommends the following treatment where the ulcers are slow in healing : A solution of borax, gr. xv to the ounce of water, or a weak solution of the nitrate of silver, gr. j to the ounce of water, or sulphate of copper, gr. v to the ounce of water, or acidum nitricum dilutum applied by means of a camel's hair pencil to the whole of the ulcerated surface, which will improve the character of the ulceration and arrest its progress.

"Any apparent cause of irritation, such as a decayed tooth, should be removed." When there is great derangement of the alimentary canal accompanying ulcerous stomatitis, or this disease occurs during the course of other acute and chronic diseases, such as pneumonia, scarlet fever, smallpox, etc., the proper remedies adapted to the removal of these diseases are necessary.

Aphthous Stomatitis.—This form of stomatitis, sometimes called "follicular stomatitis," and also "canker sore mouth," although it is not confined to the seat of the follicles, is common to all ages, but is most frequent during childhood. The seat of the aphthæ is usually the inner surfaces of the lips and cheeks, the gums, the tongue, and sometimes the roof of the mouth. They commence with a vascular injection, which is followed in a few hours by a whitish exudation immediately below the epithelium and upon the corium, in the form of small, round or oval, isolated spots, the smallest being of the size of a pin's head, but the greater number of a diameter of one or two lines, causing slight vesicle-shaped elevations on the surface of the mucous membrane. The vesicles have a whitish appearance with an inflamed ring about their base ; after their rupture an irregular gray surface is exposed, and the ulcers resulting are shallow and painful. After a few days the exudation softens, and the points become denuded of epithelium, presenting superficial, painful ulcers, but without indurated edges. After an existence of one or two weeks the aphthæ disappear, leaving red spots, which, however, soon fade. Besides being very painful to the touch, and also to foods and liquids, they are attended with an increased secretion of saliva.

Two or more of the ulcers may coalesce, forming one large ulcerated

patch, to the edges of which vegetable fungi may adhere; in rare cases, it may become gangrenous, when the affection is usually complicated with gastro-intestinal disease. The constitutional symptoms are generally slight, except when there is a tendency to gangrene, which may cause a feeble pulse, pallid countenance, wasted body and limbs, and great prostration.

The causes of aphthous stomatitis may be bad hygienic conditions, uncleanliness, and privation, but is usually owing to some derangement of the digestive organs, when it may also be accompanied with diarrhea. It differs from ulcerous stomatitis in form of the aphthæ, and the inflammation being confined to the immediate vicinity of the ulcers, and not extending over the mouth.

The treatment of aphthæ consists in the application of demulcent drinks, such as the mucilage of gum acacia, flaxseed, or marshmallow. Mel-boracis, honey of borax, is an efficient application applied with a camel's-hair pencil, and a small quantity of some opiate to relieve the tenderness of the ulcers and the restlessness. When the ulcers, besides being painful, are not disposed to heal, they may be touched with nitrate of silver or with hydrochloric acid in honey of roses, or nitric acid applied on the sharpened end of a stick of orange wood. The application of chlorate of potassium is also effective in some cases. The constitutional treatment consists in the administration of citrate of magnesia or rhubarb to correct the intestinal trouble, and tonics of sulphate of quinin or other vegetable bitters, or of the tincture of the chlorid of iron, to keep up the strength. When there is a great number of the ulcers, with considerable fever, and symptoms of cerebral congestion or of convulsions, the administration of laxatives and the bromids, with a warm foot-bath, will prove beneficial.

Thrush.—This affection, also known as "sprue" and "muguet," is characterized by a form of inflammation which consists of points and patches of a curd-like appearance on the surface of the mucous membrane of the mouth, its common seat, as the fauces, pharynx, and esophagus are only occasionally affected.

Thrush commences as simple inflammation of the mucous surface, which is followed by the appearance of minute semi-transparent points or granules, which soon become white and opaque. While some remain as points, others extend, and by coalescing form patches, the surfaces of which are not uniform, but unequally elevated.

The central part of the points and patches project but little above the surrounding epithelial surface, being not more than a line in height. They resemble in color and consistence portions of curdled

milk, for which they may be mistaken. Being very easily detached, they are rapidly reproduced, and their white color may change to a yellow hue.

Composed of epithelial cells and a parasitic vegetable growth, of the oïdium albicans variety, each point consists of roots, branches, and sporules, the roots being transparent, and penetrating the epithelial layer, and sometimes even as far as the basement membrane. The branches divide and subdivide, and consist of elongated cells with one or two nuclei. Around the branches are numerous sporules. Thrush, in its mildest form, appears in points or small patches; and if the patches are of large extent, which, however, rarely occurs, the affection is attended by a state of great prostration and danger from some concomitant disease. Often it occurs as the sequel of pneumonia or gastro-intestinal inflammation, in the latter case being caused by neglect, improper food, or a deprivation of the maternal milk. In the mildest cases the symptoms are similar to those of simple stomatitis. When the inflammation is more extensive, and especially if the fauces and esophagus are involved, the inflamed surface becomes very hot, red, and painful, and there is fretfulness and fever. In the severest forms, the surface becomes dry and parched, the inflammation more extensive, and there is thirst, loss of appetite, vomiting, and frequently diarrhea, with an anxious, pallid countenance, rapid emaciation, and extreme prostration.

When thrush is complicated with aphthæ, small, white, flocculent patches appear on the surface of the mucous membrane, which increase in size and finally coalesce. In such patches some form of vegetable parasite exists, more commonly that known as oïdium albicans.

The causes of thrush are bad hygienic conditions, constitutional feebleness, indigestion, and improper food. It is common among emaciated children in crowded institutions, or where there is exposure to dampness. Foul nursing-bottles are also a common cause of this affection. It appears to be more prevalent during the summer months, and to occur more frequently under the age of three months.

Even children of eighteen months, suffering from debilitating diseases, are subject to it. The stools are greenish and acrid, giving rise to excoriations of the parts with which they come in contact. When this disease occurs in adults, it is attended with an increased flow of saliva and a dry, hot state of the mouth, rendering deglutition painful.

The treatment of thrush should commence with an improvement in the diet and locality, if these are at fault, and the administration of

an alkali to correct the acidity of the secretions which is usually present. Saccharate of lime added to the milk is very beneficial. The following combination is recommended by Dr. Sudduth:—

℞.	Infusi rhei,	℥iij.	
	Potassi bicarb.,	ʒj.	
	Tincturæ cinnamomi,	ʒij.	
	Syrupi simp.,	ʒvj.	M.

Dose. A teaspoonful every three hours for an adult.

Quinin in one-grain doses every three hours will prove beneficial for infants. The quinin may be combined with tincture of the chlorid of iron to produce a tonic effect, one dram of the quinin with one ounce of the iron, in doses of fifteen drops every three hours. Dr. Trousseau recommends the following alterative tonic, which is very effective:—

℞.	Hydrarg. chloridi corrosivi,	gr. j–ij.	
	Liq. arsenici chloridi,	f℥j.	
	Tinct. ferri chloridi,		
	Acid. hydrochlorici dil., ... āā	fʒiv.	
	Syrupi,	f℥iij.	
	Aquam, . . . ad	f℥vj.	M.

Dose. One dessertspoonful in a wineglassful of water after each meal.

The local treatment consists in the application of borax with honey—mel-boracis—or borax with powdered sugar, or dissolved in water. Some object to the use of sugar, as it promotes the growth of the parasite. Prof. J. L. Miller recommends the following:—

℞.	Sodii borat.,	ʒj.	
	Glycerinæ,	ʒij.	
	Aquæ,	ʒvj.	M.

SIG.—To be applied with a camel's-hair pencil four or five times a day.

If such an application fails, which is rarely the case, then recourse must be had to a solution of nitrate of silver or sulphate of zinc.

℞.	Zinci sulph.,	gr. ij–iv.	
	Aquæ rosæ,	℥ij.	M.

When thrush is complicated with other diseases, the proper treatment for such diseases may render its treatment easy and effectual.

Gangrene of the Mouth.—This disease, characterized by such names as "Cancrum Oris," "Gangrenopsis," "Canker of the Mouth," "Water Canker," is common to children of debilitated constitutions and a decided lymphatic temperament, the result of scanty nourishment, improper clothing, and damp, unhealthy places of abode, or

where many children are crowded together in charitable institutions. There are several forms of this affection, the most common, perhaps, being preceded by inflammation of the gums, with such premonitory symptoms as great languor and listlessness, indisposition to any exercise, irritable temper, loss of sleep and appetite, and increase of thirst. The countenance becomes pale and dejected, and a peculiar puckering of the cheeks is observed about the corners of the mouth. Emaciation and night-sweats are not uncommon.

These premonitory symptoms may continue for several days, or even weeks, when an acute pain is felt in the mouth and gums, with a sense of heat and itching about their margins, the free edges of which become congested and thickened, spongy, and of a dark red or purple hue, bleeding readily.

The flow of saliva increases greatly, and is frequently mixed with blood. From about the necks of the teeth a muco-purulent matter is discharged, which after a time becomes thin, watery, and acrid, rendering the breath very offensive. In the majority of cases this disease is confined to one side of the mouth and to the lower jaw, and if allowed to progress, the gums separate from the necks of the teeth and alveolar processes, and become ragged, flabby, and livid; the teeth on the affected side loosen, and at length drop out, and at this stage there is an increase of the febrile symptoms and night-sweats. In such a state the gums may continue for weeks or even months, but usually after a few days a number of ash-colored vesicles make their appearance, which rapidly increase in size and become confluent, the divided gum presenting a gangrenous appearance. The dead portions separate, a gangrenous ulcer follows, and soon the entire part is destroyed and the inferior maxillary bone exposed. The ulceration is more common to the labial surface than to the lingual, and commences in the front part of the mouth, extending to posterior parts. The ulcers, before becoming gangrenous, are covered with a yellow or gray secretion, which, on being removed, exposes many small, red papillæ, which correspond to imperfect granulations. After a time the gangrenous ulceration extends to the mucous membrane of the cheek and lips, causing pain and difficulty in attempting to open the mouth, which is sometimes impossible.

In a short time the whole of the mouth becomes affected, and death usually occurs at about the eighth or, at the furthest, upon the fourteenth day from the commencement of the gangrene.

Mr. Tomes remarks that although the disease is usually confined to children during the shedding of the temporary teeth, yet adults are not wholly exempt from its attacks.

There is another form of this disease which differs considerably

from that just described, from the fact that it is not preceded by inflammation of the gums, but commences in the cheek, usually at the angle of the lips, and comes on abruptly, without the premonitory symptoms characteristic of the first form described.

There is first seen a hard, indolent tumor, about the size of an almond, in some part of the lips or cheek, which is deeply seated, the skin covering it being somewhat redder than natural. This tumor gradually increases in size for a few days, when the mucous membrane covering it presents a gangrenous appearance, with an offensive odor. Before this occurs, however, the external redness of the skin covering the tumor becomes pale, then livid, then of a grayish hue, surrounded by a red circle, which spreads rapidly and in a few hours changes to a black color.

The gums nearest to this tumor then become gangrenous, and the teeth loosen and at length fall out. Death usually occurs before the death of the bone of the jaw. There is also a superficial form of gangrene sometimes met with in the form of spots of a dark-brown color surrounded by a red margin, which vary in size, and have for their seat the corners of the lips and inner surfaces of the cheeks. These spots may first appear in the form of slightly reddened patches, but in this mild form are always superficial, confined to the mucous membrane alone, the sloughs separating with little loss of substance, soon to be followed by healthy granulations and cicatrization.

Gangrene of the mouth may occur at any period between the first and tenth year of age, but is more common between the second and fourth years ; and the children subject to it are those of a lymphatic temperament, delicate constitution, soft, flaccid muscles, pale skin, and whose digestive organs are deranged. It usually occurs in those whose systems are much reduced or cachectic, and is more common to children crowded together in asylums and those deprived of pure air and proper nourishment, or enfeebled by disease. It sometimes follows the eruptive fevers, and such diseases as pneumonia, scrofula, whooping-cough, typhus fever, ague, etc.

In the treatment of gangrene of the mouth no little depends upon the time this is instituted. Before the gangrene makes its appearance much may be done in the way of preventive treatment, in order to remove the existing predisposition. A dry, pure air, cleanliness, and a nourishing diet adapted to the condition of the digestive organs are very essential. The preparations of iron and bitter vegetable tonics are required.

The administration of the sulphate of quinin, and the local application of a strong decoction of white oak bark, is thought, by Dr. Condie, to be beneficial in preventing gangrene of the mouth in cases

in which there is every reason to anticipate its speedy occurrence. For local treatment solution of sulphate of zinc (one dram to the ounce of water), to which is added honey and tincture of myrrh, two drams of each, will prove serviceable. Nitrate of silver, either in the solid form or in solution, applied to the affected part, has been successfully employed in a large number of cases.

When the disease is established, the first indication in the local treatment is to arrest the progress of the gangrene and hasten the detachment of the slough, and for such purposes highly stimulating or escharotic agents are required. The affected parts should be well cleansed, and then sprayed with carbolized water and strong acetic, sulphuric, nitric, or hydrochloric acids, nitrate of silver, acid nitrate of mercury, or chlorid of antimony, applied, by means of a brush, on and about the slough, to be at once followed by the application of dry chlorid of lime, when the mouth is to be thoroughly washed out with water, by means of a syringe. By such applications to the edges of the ulcers, the diseased tissue is destroyed and healthy granulations promoted.

After the separation of the slough the escharotic is to be discontinued and the chlorid of lime alone employed. Some, however, prefer milder remedies than the strong acids, such as the nitrate of silver, if the slough is small in extent; if larger, muriated tincture of iron is applied, undiluted, and after the progress of the gangrene is arrested the use of astringent stimulants, such as tincture of myrrh or the French aromatic wine.

Dr. Coates found sulphate of copper, according to the following formula, to be successful:—

℞. Cupri sulph., ... ʒij.
Pulv. cinchonæ, ... ℥ss.
Aquæ, ... ℥iv. M.

To be applied twice a day to the entire ulcerations and excoriations.

In milder cases a solution of sulphate of zinc, ʒj to an ounce of water, by itself or combined with tincture of myrrh, is found to be useful. If the milder agents, after two or three days' use, do not prevent the gangrene from spreading, strong hydrochloric acid, applied by a camel's-hair pencil, may prove efficacious, and its use immediately followed by lime-water made turbid by lime. To correct the fetor, chlorin or carbolic acid, properly diluted, may be employed alternately with the sulphate of copper, or Labarraque's solution of chlorinated soda, one part to eight or ten parts of water. The tincture of myrrh, with tonics and a nutritious diet, should complete the treatment.

Dr. Condie recommends the administration of sulphate of quinin during the time the local remedies are being applied, as follows:—

℞. Quiniæ sulphat.,	gr. x.		
Acid. sulph. dil.,	♏x.		
Sacch. alb.,	ʒiv.		
Aq. cinnamom.,	℥iv.	M.	

Dose: A teaspoonful every three hours.

The free internal use of the chlorate of potassa, one to three scruples in twelve hours, according to the age of the child, has been employed with advantage.

For the diarrhea accompanying the disease, and especially when it is profuse, Dr. Condie recommends acetate of lead, as follows:—

℞. Acetat. plumbi,	gr. xvj.	
Cretæ præp.,	℈iiss.	
Ipecacuanhæ,	gr. iv.	
Opii pulv.,	gr. ij.	M.

To be divided in xvj portions; one to be given every three or four hours.

Syphilitic Ulceration of the Mouth.—Syphilitic ulcers are the secondary results of constitutional syphilis, and are usually found on the tongue, the lips, or the tonsils. Although the syphilitic ulcer is usually superficial, little irritating, and attended with the discharge of a small amount of pus, it is occasionally phagedenic in character. Such ulcers, as a result of constitutional syphilis, may be incited by abrasions and injuries caused by fractured and carious teeth upon the sides of the tongue, and they may appear on the lip as the result of kissing. These ulcers also appear upon the tonsils and pharynx. These syphilitic ulcers may be distinguished from more malignant ones by their improvement under specific medication and the other indications of constitutional syphilis generally present and recognizable. The glands of the neck are often found enlarged when syphilitic ulcers exist in the mouth or on the lips. Local and constitutional treatment is required in the majority of cases. The local treatment consists in the application of a solution of chromic acid—ten grains to the ounce of water—by means of a camel's-hair brush, three times a day. When such applications fail, the administration of mercury is necessary; and in all cases a total abstinence from alcoholic drinks and tobacco is required.

Mercurial Stomatitis.—The employment of mercury as a medicinal agent causes increased watery evacuations, increased flow of bile and saliva, and, as a consequence, increases the flow of blood to the secreting part. But when administered in excess other effects follow. It is

capable of producing inflammation, especially the acute, phlegmonous, adhesive variety. The effects of its use depend upon the quantity administered and the susceptibility of the patient to its action. When carried to excess, the mucous membrane of the mouth becomes tender, red, and swollen, the glands beneath the jaw become painful, and at length ulceration occurs, which spreads from the gums—where the effects of the drug are first observed—to fauces and throat, and, in extreme cases, the parts affected may perish.

Prof. Wood describes the disease as follows: "Among the first indications of the action of mercury are often a metallic taste in the mouth, like that of brass or copper, and some increase of saliva. At the same time a close examination will detect a slight redness and swelling of the gums, particularly about the necks of the lower incisors, while somewhat below their edge a broad, white line may be observed, depending on opacity of the epithelium.

"The patient soon begins to feel some uneasiness, complaining of soreness when the gums are pressed, and of pain when the teeth are forcibly closed together. There is also a sense of stiffness about the jaws when the mouth is opened, and they feel as if projecting above their proper level. The flow of saliva increases, the inflammation extends, the gums and palate become obviously swollen, and the tongue covers itself with a yellowish-white or brownish fur, and is often so much enlarged as to exhibit the impression of the teeth upon being projected from the mouth. The throat frequently becomes sore, and the cheeks and salivary and absorbent glands swollen and painful. There is often severe toothache or pain in the jaws. A whitish exudation along the edges of the gums is very common.

"The breath, which sometimes from the beginning, and sometimes even before the appearance of any one of the symptoms mentioned, has a peculiar, disagreeable odor, now becomes extremely offensive, and in bad cases almost intolerable. Ulceration often occurs, especially about the necks of the teeth, which are consequently loosened, and in the cheeks, lips, and fauces. The ulcers often have their origin in a vesicular eruption. The whole mouth with its appendages is sometimes so swollen that it can scarcely be opened, and the tongue so much enlarged as to project beyond the lips.

"The patient is now nearly or quite unable to articulate or to masticate his food, and sometimes can scarcely swallow. Hemorrhage is not an unfrequent attendant upon the bad cases, and is sometimes so profuse as to be alarming. Sloughing also takes place, and portions of the jawbone are occasionally laid bare. There is always in the severe cases more or less fever, which is partly symptomatic of the local affection and partly the direct effect of the mercury. Death, from

the exhausting influence of the irritation, want of nourishment, and hemorrhage, has occurred in numerous instances, but the patient usually recovers from the worst forms of the affection, though sometimes with a deformed mouth.

"The tongue and cheeks have occasionally adhered at points where their ulcerated surfaces were in contact, and a surgical operation has been necessary to remove the evil."

For the treatment of mercurial stomatitis, see "Treatment of Mercurial Inflammation of the Gums."

Scurvy-Scorbutus is a disease characterized by spongy gums, offensive breath, livid spots on the skin, great general debility, and a pale, bloated countenance.

"Scurvy," remarks Prof. Wood, "is generally very gradual in its approach, so that it is scarcely possible to say, in any particular case, what was its precise time of attack. Attention is commonly first attracted by an unhealthy paleness of complexion, a feeling, on the part of the patient, of languor and despondency, with an indisposition to bodily action, and unusual fatigue after exercise; a sensation of weariness and aching in the limbs, as from over-exertion, though the patient may have been at rest; and some swelling, redness, and tenderness of the gums, with a tendency to bleed from slight causes. With the advance of the disease, the face becomes paler, and assumes a somewhat sallow or dusky hue, and often a degree of puffiness; the lips and tongue become pallid and contrast strikingly with the gums, which are purple or livid, especially at their edges, rise up between and around the teeth, are soft and spongy, and bleed from the slightest touch; the breath is offensive; purplish spots or blotches appear upon various parts of the surface, beginning usually upon the lower extremities, and afterward extending to the trunk, arms, and neck, though seldom affecting the face; hemorrhage frequently occurs, most commonly from the nose, gums, and mouth, but sometimes from the stomach, bowels, and urinary passages; the feet become edematous and the legs swollen and painful; the general debility increases, and muscular exertion is apt to be attended with palpitation of the heart, panting, vertigo, dizziness, and a feeling of faintness. The petechial spots are evidently owing to the extravasation of blood within the cutaneous tissue. Occasionally portions of the surface look as if bruised without having suffered any violence; and blows which, under ordinary circumstances, would produce no effect, now give rise to extensive ecchymosis. Should the disease continue, all the symptoms become aggravated; the complexion assumes often, with its paleness, a livid or leaden hue; the gums swell greatly, and put forth a blackish, fungous growth, so as sometimes to conceal the teeth; blood con-

tinually oozes from them ; sloughing occasionally takes place, laying bare the necks of the teeth, and extending, in very bad cases, even to the cheek.

"The teeth become loose and sometimes fall out ; the patient is unable to chew solid food, in consequence of the state of his gums. The breath becomes intolerably offensive ; hard and painful tumefactions occur in the calves of the leg, among the muscles of the thigh, upon the tibiæ and lower jaw, and in the hand, with stiffness and contraction of the joints, especially the knee, and severe pain in the extremities upon every attempt at movement ; and the debility, before so prominent a feature in the case, now becomes excessive, so that the least exertion is dangerous, and the patient sometimes dies suddenly upon rising from bed or upon being conveyed, without great caution, from one place to another. Wounds, even slight scratches, degenerate into unhealthy ulcers ; old cicatrices break out afresh, and existing ulcers assume a new and much worse aspect. The bones are said to be softened, united fractures are again opened, and in the young the epiphyses separate sometimes from the shaft.

"Throughout the complaint the tongue is usually clean and moist ; and the appetite and digestion remain unimpaired almost to the last, unless the disease, as sometimes happens, should be complicated with fever. Indeed, there is often a craving for food, especially for fresh vegetables and fruits ; occasionally, however, there is vomiting, with epigastric distress and other evidences of stomachic disorder. The bowels are mostly costive, and in some cases obstinately so, but diarrhea not unfrequently intervenes, with black or bloody and offensive evacuations. The pulse is generally small, feeble, and slow ; but cases occur in which it becomes very frequent, and the surface of the skin febrile, probably from the sympathy of the system with various local irritative congestions.

"Great emaciation usually attends the disease when severe or lasting, but not invariably. Little cerebral disturbance is ordinarily observable, and the patient often retains full possession of his senses and intellect to the last."

In regard to the cause of scurvy, it is the general belief that it results from the absence of fresh vegetables and fruits. Prof. Hamilton says : "In regard to the pathology of scurvy, the belief prevails that it is due essentially to the absence of certain staminal principles from the blood, and especially potash, as all, or nearly all, the remedies which have been employed successfully in the prevention or cure of scurvy contain potash, such as potatoes, cabbage, celery, lettuce, lime, lemon, and orange juice." As regards the treatment, both local

and constitutional are required. The local treatment, being the same as is recommended for "Mercurial Stomatitis," need not be repeated. The constitutional treatment consists in the administration of the vegetable acids, such as lemonade, for example. Turner's antidote, composed of potassæ nitratis ʒij, and acidi acetici ℥viij, in tablespoonful doses, three times a day, is a favorite remedy. In connection with this, Dr. Garretson recommends saturating a sheet with water moderately warm and moderately salt, which is thrown around the body each morning immediately on rising, and rubbed against the flesh until a ruddy glow is excited.

CHAPTER IV.

DISEASES OF THE GUMS.

THE gums frequently assume various morbid conditions, but as many of the lesions which affect the oral mucous membrane have been described under "Diseases of the Oral Mucous Membrane," it will only be necessary to refer to such affections as are confined to the gums.

The diseases of the gums are divided into two classes: those which are the result of local irritation, and those which arise from constitutional causes.

Were it not for local irritation in these parts, the constitutional tendencies to disease would rarely manifest themselves; and, on the other hand, were it not for constitutional tendencies, the effects of local irritation would seldom be of a serious character.

Each constitution has its peculiar tendency; or, in other words, is more favorable to the development of some form of disease than others; and this tendency is always increased or diminished according to the healthy or unhealthy performance of the functional operations of the body generally. Thus, derangement of the digestive organs increases the tendency, in an individual of a mucous habit, to certain forms of diseased action in particular organs, and especially in the gums. A local irritant, which would otherwise produce only a slight inflammation of the margins of the gums, would now give rise to turgidity and sponginess of their whole structure. The same may be said with regard to a person of a scrofulous or scorbutic habit.

The susceptibility of the gums to the action of morbid irritants is always increased by enfeeblement of the vital powers of the body. Hence, persons laboring under excessive grief, melancholy, or any other affection of the mind, or under constitutional disease tending to

enervate the vital energies of the system, are exceedingly subject to inflammation, sponginess, and ulceration of the gums. But, notwithstanding the increase of susceptibility which the gums derive from certain constitutional causes and states of the general health, these influences may, in the majority of cases, be counteracted by a strict observance of the rules of dental hygiene; or, in other words, by constant and regular attention to the cleanliness of the teeth.

A local disease, situated in a remote part, often has the effect of diminishing the tendency in the gums to disease; but when, from its violence or long continuance, the general health becomes implicated, the susceptibility of these parts is augmented.

Although deriving their predisposition to disease from a specific, morbid constitutional tendency, they, nevertheless, when diseased, contribute in no small degree to derange the whole organism. Their unhealthy action vitiates the fluids of the mouth and renders them unfit for the purposes for which they are designed; hence, when these parts are restored to health, whether from the loss of diseased teeth or the treatment to which they may have been subjected, the condition of the general health is always immediately improved.

Thus, while the susceptibility of the gums to morbid impressions is influenced by the state of the general health, the latter is equally influenced by the condition of the former And not only is a healthy condition of the gums essential to the general health, but it is also essential to the health of the teeth and alveolar processes. From the intimate relation that subsists between the former and the latter, disease cannot exist in one without in some degree affecting the other. Caries of the teeth, for example, often gives rise to inflammation of the gums and peridental membrane; on the other hand, inflammation of these parts vitiates the fluids of the mouth and causes them to exert a deleterious action upon the teeth, and also excites more or less constitutional derangement.

The gums appear bloodless and pale in general anemia, or chlorosis; also edematous as a result of catarrhal stomatitis, or after typhoid fever, or during pregnancy. The gums also become hyperemic, assuming a bluish-red color, and bleeding from the slightest injury, a condition which may also arise during pregnancy, or result from mercurial poisoning, or exposure to the irritating action of acids and other poisons.

INFLAMMATION OF THE GUMS.—ULITIS.

Acute inflammation of the gums frequently occurs in connection with stomatitis, or general inflammation of the mucous membrane of the buccal cavity, which appears under a great variety of forms. In this case the inflammatory action does not always extend to the sub-

jacent fibro-cartilaginous structure; but the local disease is often complicated with other disorders, the treatment of which comes more properly within the province of the medical than that of the dental practitioner. Ulitis, or acute inflammation of the gums, is, in most cases, a purely local disease, arising from mechanical injury, such as the irritation of artificial teeth, etc. Other common causes are the accumulation of salivary calculus on the necks of teeth, decomposing particles of food at the borders of the gums and in the space between the gum and the neck of the tooth, and the accumulation of micro-organisms. Ulitis also arises from the presence of carious, dead, loose teeth, and teeth irregularly placed. When the gums are in contact with, or overlap the edges of carious cavities, they become irritated and inflamed, and in many instances protrude into such cavities in the form of lobulated tumors of such a size as to more or less fill up the cavity. A vitiated condition of the fluids of the mouth will also cause ulitis; it may also arise from the irritation of dentition or as a consequence of periodontitis. It often extends to the submaxillary glands and muscles of the face, and is attended by swelling and other morbid phenomena. But as this form of inflammation of the gums is treated of in connection with Stomatitis, it will not be necessary to repeat what we have said elsewhere concerning it.

The chronic form of ulitis may exist for years without being attended with suppuration or recession of their margins from the necks of the teeth; but these phenomena are sooner or later developed, according to the amount of local irritation and the state of the constitutional health and habit of the body. With the occurrence of inflammation the margins of the gums gradually lose their festooned appearance, become thick, spongy, and rounded, and ultimately, on being pressed, purulent matter is discharged from between them and the necks of the teeth. Their sensibility is increased and they bleed from the most trifling injury.

The diseased action usually first develops itself in the gums around the lower front teeth and the upper molars, opposite the mouths of the salivary ducts, also in the immediate vicinity of aching, decayed, dead, loose, or irregularly arranged teeth, or in the neighborhood of roots of teeth; from thence it extends to the other teeth. The rapidity of its progress depends on the age, state of the general health, temperament and habit of body of the individual, and the character of the local irritant which has given rise to it. It is always more rapid in persons addicted to the free use of spirituous liquors, and in individuals in whom there exists a scorbutic tendency, or who have suffered from venereal disease, or from the constitutional effects of a mercurial treatment used to cure this or other diseases.

The inflammation may be confined to the gums of two or three teeth, or it may extend to the gums of all the teeth in one or both jaws.

As the disease advances, the gums begin to recede from the necks of the teeth, and the alveoli to waste, and the teeth, as they lose their support, loosen and ultimately drop out. In Fig. 118 is represented a case in which nearly one-half of the roots of the lower incisors have become exposed by this devastating process.

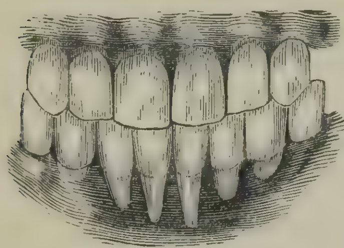


FIG. 118.

But the loss of the teeth, though it puts a stop to the local disease, is not the only bad effect that results from it. Constitutional symptoms often supervene, more vital organs become implicated, and the health of the general system is sometimes very seriously impaired. Hence, the improvement often observed after the loss of the teeth in the general health of persons whose mouths have for a long time been affected with this disease.

The loss of the teeth, from the wasting of the gums and alveolar processes, although occurring frequently in advanced life, is not a necessary consequence of senility, for we occasionally see persons of seventy, and even eighty years of age, whose teeth are as firmly fixed in their sockets, and their gums as little impaired, as in individuals at twenty. But it is of little importance whether it be the result of old age, a constitutional tendency, functional derangement of some other part, or local irritation, since the consequences resulting from such loss are always the same.

The gums, after having been once the seat of chronic inflammation, are ever after more susceptible to the action of morbid irritants.

In scrofulous diatheses, the gums, instead of being purple and swollen, may become pale and harder than ordinary, and, on being pressed, discharge muco-purulent matter of a dingy white color. They often remain in this condition for years without appearing to undergo any structural alteration or to affect the alveolar processes. It rarely occurs before the age of eighteen or twenty, and it seems to be the result of impaired nutrition. The gums exhibit no signs of inflammatory action; on the contrary, they are paler, less sensitive, and possess less warmth than usual. It is never attended with tumefaction or absorption, except in its advanced stages.

Treatment.—In the treatment of ulitis, the first thing claiming the attention is the removal of the exciting causes. If there are dead or

loose teeth in the mouth, or teeth which, from their position, act as mechanical irritants, they should be at once extracted. The remaining teeth should, at the same time, be freed from salivary calculus and all other irritating depositions, in such a thorough manner as to permit none to remain, either about the necks or beneath the margins of the gums; and, if necessary, all deposits should be removed from about the very ends of the roots of the teeth, so far, at least, as the separation of the gums from the teeth extends. All necrosed portions of process should also be removed, and the entire surfaces of the exposed portions of the roots of the teeth be well polished. Besides removing the tartar, if the gums are much congested they should be scarified around the necks of the teeth and all hypertrophied growths in the interstices cut away. The bleeding which follows such operations should be promoted by frequently rinsing the mouth with warm water.

It is essential, in the treatment of the disease under consideration, that a decided impression be made upon it at once; consequently, no time should be lost in the removal of local exciting causes.

Several sittings are often required for the complete removal of calcic deposits when present.

The cure may be hastened by washing the mouth several times a day with some tonic and astringent lotion. The author has found combinations of powd. nutgalls, cinchona, and orris root in infusion of roses, to be very serviceable; also as gargles, combinations of chlorate of potassium and borax, in water; also, tannic acid, chlorate of potassium, with honey of roses and water; also, tinct. of capsicum, cologne water, borax, tinct. of cinchona, and tincture of pyrethrum with water. When there is much soreness, a combination of borax, honey and sage tea will prove soothing and healing.

The pleasantest, and at the same time the most efficacious, mouthwash which the author has ever employed is the following:—

℞.	South American soap bark, ...	8 ounces.
	Pyrethrum, Orris root, Benzoic acid, Cinnamon, ... each	1 ounce.
	Tannic acid, ...	4 drachms.
	Borax, ...	4 scruples.
	Oil of wintergreen, ...	2 fluidrachms.
	Oil of peppermint, ...	4 "
	Cochineal, ...	3 drachms.
	White sugar, ...	1 pound.
	Alcohol, ...	3 pints.
	Pure water, ...	5 "

Mix ingredients thoroughly, digest for six days, and filter.

The following combinations are also serviceable :—

℞.	Acid carbolic., ...	gtt. v.	
	Glycerini, ...	℥j.	
	Ol. caryophylli, ...	gtt. v.	M.
℞.	Sodæ sulphis, ...	ʒj.	
	Glycerini, ...	℥j.	M.
℞.	Acid carbolic., ...	ʒss.	
	Glycerini, ...	ʒxv.	M.
℞.	Sodæ boras.	ʒij.	
	Glycerini, ...	℥j.	
	Aquæ, ...	℥iv.	M.

In mild cases of inflammation of the gums and mucous membrane of the mouth, iodin in glycerin—saturated solution—is an excellent application.

For ulceration of the gums and mucous membrane of the mouth see "Ulcerous Stomatitis."

For soft, swollen, and spongy gums, the French preparation known as *Phénol Sodique*—phenate of soda—a teaspoonful to a tumbler of water, will prove beneficial.

If, notwithstanding the use of the means here recommended, matter still be discharged from around the necks of the teeth, and should the gums continue spongy and manifest no disposition to heal, their edges may be touched with a solution of the chlorid of zinc or nitrate of silver. This will seldom fail to impart to them a healthy action. Either remedy may be used in the proportion of from one to three, or even six grains to one ounce of water. The most convenient mode of applying them, is with a camel's-hair pencil, and they will often succeed when other remedies fail. In those cases where the matter discharged from the edge of the gum has a nauseating and disagreeable odor, a preparation composed of carbolic acid fʒij ; oil of gaultheria, fʒij, and aqua rosæ, fʒiij, of which ten to twenty drops may be added to a wineglass of water and used as a gargle, or applied on lint to the inflamed surface, is an excellent remedy for rendering the mouth comfortable. An excellent disinfectant in such cases is a gargle made by diluting a teaspoonful of chlorinated soda (Labarraque's solution) in four or eight ounces of water. Or it may be used much stronger, and applied with a small mop to the diseased parts ; phénol sodique is also an excellent disinfectant.

While the means here directed for the cure of the disease are being employed, a recurrence of its exciting causes must be studiously guarded against. Tartar and foreign matter of every kind should be

prevented from accumulating on the teeth, by a free and frequent use of a suitable brush and waxed floss-silk, until a healthy action be imparted to the gums; these should be used at least five times a day—immediately after rising in the morning, after each meal, and before retiring at night. The application of the brush may at first occasion some pain; but its use should nevertheless be persisted in, for, without it, all the other remedies will be of little avail. The friction produced by it, besides keeping the teeth clean, is of great service to the gums, in imparting to them a healthy action.

The treatment necessary in that form of disease which we noticed as being characterized by preternatural paleness and discharge of muco-purulent matter from between the edge of the gum and the neck of the tooth, consists of the use of tonics, free exercise in the open air, and the application to the edges of the gums of nitrate of silver, followed by the daily use of an astringent mouth-wash.

HYPERTROPHY, OR MORBID GROWTH OF THE GUMS.

The structural changes which take place in the gums as a consequence of increased vascular action are almost as various as are the constitutional tendencies of different individuals. The affection of which we are now about to treat is characterized by a morbid growth, which is sometimes so considerable that it almost covers the crowns of the teeth, thus interfering very seriously with the function of mastication. When thus affected, the gums have a dark purple color, with thick, smooth, and rounded margins, and discharge almost constantly from their inner surface, a thin, purulent matter, which exhales an exceedingly offensive odor. They bleed profusely from the slightest injury, and are so sensitive that the pressure even of the lips is sometimes attended with pain. They are also affected with a peculiar itching sensation, which at times is a source of great annoyance. Microscopic investigation shows the fibrous stroma of the gum tissue to be unduly increased, but without the presence of any new glandular or epithelial elements.

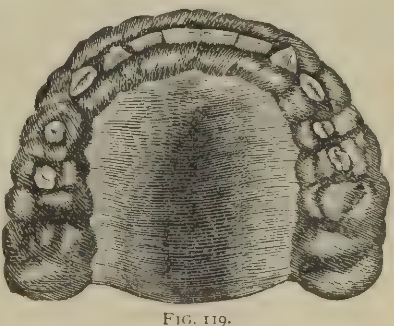


FIG. 119.

The accompanying engraving (Fig. 119) will convey to the reader a more correct idea of the appearance of the gums when thus affected, than any description which can be given. It will be perceived from

this that the morbid growth extends to the gums of all the teeth, as it usually does in this variety of diseased action.

Among the local and constitutional effects arising from the disease are offensive breath, vitiated saliva, destruction of the alveoli, with loosening and ultimate loss of the teeth, impaired digestion, with all its disagreeable concomitants, enlargement of the tonsils and bronchitis, together with a long train of other phenomena.

Causes.—The exciting cause of this peculiar affection is local irritation, produced by salivary calculus, dead, diseased, or irregularly arranged teeth; but the character of the structural alteration is evidently determined by some cachectic habit of body or constitutional tendency. It often attacks the gums of individuals whose teeth are sound and well arranged; but the author has never met with a case in which salivary calculus was not present, though in some instances the quantity was so small as almost to lead one to doubt whether it could have had much agency in the production of the disease. But the susceptibility of the gums to morbid impressions in individuals liable to this affection is usually so great that an irritant which under other circumstances would scarcely excite an increase of vascular action, gives rise, in cases of this sort, to the rapid development of an aggravated form of disease.

Treatment.—The first thing to be attended to in the treatment of this disease is the removal of all dead teeth, and such others as may in any way irritate the gums. The morbid growth should be next removed by making a horizontal incision entirely through the diseased gums to the crowns of the teeth. This should be carried as far back as the morbid growth extends. After this the gums should be freely scarified by passing a lancet between the teeth down to the alveoli, in order that the vessels may be completely divided and discharge their accumulated blood. This should be repeated several times, at intervals of four or five days. Meanwhile the mouth may be washed three or four times a day with some astringent and detergent lotion, and occasionally mopped with a weak solution of chlorid of zinc or nitrate of silver, one grain to the ounce of water. Phenol sodique—phenate of soda—either in its full strength or diluted with from one to twelve times its bulk of water, according to indications, proves very serviceable as a lotion, causing the rapid absorption of the extravasated blood, preventing fetor, and speedily healing and hardening the gums. The salivary calculus should be removed as soon as the gums have sufficiently collapsed to admit of the operation.

In severe cases a permanent cure cannot be effected by the local treatment above described, for, in addition to the removal of the enlarged gum tissues, it may be necessary to excise the edge of the

alveolus, especially if there is necrosis of the margins present, or expansion of the alveolar border. Particular attention should be paid to the regimen of the patient and such general remedies prescribed as the peculiar nature of the case may indicate. Excess and intemperance of every kind must be avoided. In cases of an inflammatory type, the diet should be chiefly vegetable ; but where there is debility or other cachexia, animal food should be used, taking care to avoid all young meats, as veal or lamb, all gross meats, such as pork, and all salt meats or shell-fish. Fruits and acid beverages, such as infusions of malt and vinegar, lemon-juice, spruce beer, etc., may be used with advantage.

The teeth should be kept perfectly and constantly clean. Not a particle of foreign matter should be permitted to remain between them or along the edges of the gums. A scrupulous attention to this precaution is indispensably necessary, as it constitutes one of the most important remedial indications.

MERCURIAL INFLAMMATION OF THE GUMS.

Small and repeated doses of mercury, when carried to the point of salivation, frequently give rise to the development of peculiar morbid phenomena in the gums and other parts of the mouth. The first indication of the specific action of this powerful medicinal agent upon the animal economy consists in a slightly increased redness and tumefaction of the free edge of the gums, around the necks of the inferior incisors. There is a characteristic bluish color along the edge of the gums, while the investing mucous membrane of the adherent portion, a little lower down, often assumes a white color, owing to the opacity of the epithelium. These appearances are followed by increased secretion of saliva ; a strong metallic taste ; soreness of the teeth and gums ; inflammation and swelling of the mucous membrane of the roof of the mouth, fauces and cheeks, and the salivary glands ; a swelling of the tongue, with increased redness of its edges, and a peculiarly offensive odor of breath. In the meantime, the edges of the gums about the necks of the teeth swell and assume an increase of redness ; the saliva becomes viscid, and is secreted in such abundance as to flow from the mouth, and the movements of the jaws are attended with pain. The alveolo-dental periosteum is thickened, and the teeth raised from their sockets and loosened. A vesicular eruption sometimes appears, followed by ulceration and sloughing of the gums, and very frequently by necrosis of large portions of the alveolar process and maxilla. We were shown, a few years since, the entire alveolar border of both jaws, the necrosis and exfoliation of which had been occasioned by severe mercurial salivation ; and we have frequently had occasion to remove portions both of the superior and in-

ferior maxillary bones—the necrosis having been occasioned by the use of this medicine.

By the prudent administration of mercury, salivation may be induced without causing the deplorable effects just described. But the specific action of this agent upon the constitution is always attended by more or less tumefaction and sponginess of the gums, and when once brought under its influence, however perfectly its effects may have subsided, they are ever after more susceptible to morbid impressions. Again, it should be remembered that very many of these deplorable symptoms follow the use of mercurials, even where there is no intention to salivate. It is a powerful agent, capable of much good, but one which has been productive of untold mischief, especially upon the mouth and teeth. Doubtless life must be saved at the expense, if necessary, of the teeth; but the peculiar specific action of this medicine should forbid its constant and indiscriminate employment.

Treatment.—It is scarcely necessary to say, that until the use of the mercury is discontinued it will be impossible to control or even counteract its effects upon the gums; but in mild cases these usually soon disappear after the action which it has produced on the general system has completely subsided. When the gums continue spongy, the bowels should be kept open with Seidlitz powders or other saline cathartics, the patient restricted to a fluid farinaceous diet, and the mouth gargled several times a day with mild astringent lotions, to which it may sometimes be advisable to add a little laudanum. Benefit may be derived from the application of the official tincture of iodin in a solution composed of one-half water. For internal use chlorate of potash and iodid of potassium are considered the best remedies in mercurial poisoning.

The chlorate of potash is also of very great service as a lotion, in the strength of one dram to the ounce of water.

For internal use, ten grains of the chlorate of potash may be dissolved in half an ounce of water, and administered in four or five doses during the day. For an adult, Dr. Garretson recommends the following lotion as very beneficial in cases where the tumefaction is very great and indolent looking:—

℞.	Potassæ chloras,	℥ss.	
	Sodæ boras,		
	Alumen pulv., āā	ʒij.	
	Potass. permang.,	grs. xxv.	
	Aqua cologn.,	℥ss.	
	Tinct. cinchonæ,	℥ij.	
	Tinct. myrrhæ,	℥j.	
	Infus. quercus (fort.),	℥iv.	M.

SIG.—Gargle the mouth pro re nata.

The iodid of potassium may be given in doses of from three to five grains, three times a day, in some bitter infusion; also, diluted sulphuric acid combined with bitter tonics; also the tincture of belladonna in five-drop doses three or four times daily.

The following gargle will be found very serviceable in mercurial salivation:—

℞. Tinct. iodinii,	ʒ iij to vj.	
Potassæ iodidi,	grs. xv. to xxx.	
Aquæ,	Oss.	M.

Astringent washes of tannic acid, borax, or dilute alcohol, are also serviceable.

After the action of the medicine upon the system has subsided, and the disease assumes a chronic form, the use of astringent washes should be continued, and if there are any teeth which, from the loss of their vitality or from having become very much loosened by the partial destruction of their sockets, act as irritants they should be removed; but teeth should not be sacrificed merely on account of their loosened condition, as they may become firmly fixed on the subsidence of the disease.

For correcting the fetor arising from the ulcerated surfaces, a gargle may be used composed of two or three drams of charcoal suspended by agitation in a tumbler of water. After retaining a portion of this gargle for a short time, the mouth should be rinsed with warm water to remove the particles of charcoal.

A solution of the permanganate of potash, in the strength of from two to ten grains to the ounce of water, as a gargle, or of phenol sodique in the form of spray, will also prove effective for the removal of the fetor; also washes made from chlorinated soda or lime, and solutions of listerine or borine.

ULCERATION OF THE GUMS OF CHILDREN, ATTENDED WITH EXFOLIATION OF THE ALVEOLAR PROCESSES.

The gums and alveolar processes of children are occasionally attacked by a very peculiar form of disease, which occurs more frequently during the shedding of the temporary and the eruption of the permanent teeth than at any other period of childhood. We have never known adults to be affected with it, and to the ordinary spongy, inflamed, and ulcerated gums it does not appear to be at all analogous. It bears a much closer resemblance to *cancrum oris*, yet differs in many particulars from this disease.

Among the symptoms which characterize the affection are itching and ulceration of the gums and their separation from the necks of the

teeth and alveolar processes; there is, at first, a discharge of muco-purulent matter from between the gums and necks of the teeth, which ultimately becomes ichorous and fetid. The teeth loosen, and the alveoli lose their vitality and exfoliate. Ulcers are formed in various parts of the mouth, and the gums and lips assume a deep red or purple color. In the exfoliation of the alveolar processes the temporary, and sometimes the crowns of the permanent teeth, are carried away. The constitutional symptoms are: skin, for the most part, dry; pulse, small and quick; the bowels generally constipated, though sometimes there is diarrhea; and to these symptoms may be added lassitude and a disposition to sleep.

These may be regarded as the prominent phenomena of the disease in its most aggravated form. When exfoliation of the alveolar processes takes place, the symptoms usually abate, and sometimes wholly disappear.

In the majority of cases the disease is confined to one jaw and to one side, though sometimes both are affected by it. The effect on the permanent teeth, in all the cases which have fallen under the notice of the author, was injurious.

Causes.—The disease seems to be the result of general debility or defective nutrition and a cachectic habit of body. It appears to be almost wholly confined to children of the poor and destitute, and, so far as the author's observations extend, to those who reside in cellars or small and confined apartments. Children of scorbutic habit seem to be the most subject to it. From the great debility of all the organs of the body, their functions are languidly and imperfectly performed. That the disease is determined by general enfeeblement of the functions of the body there is, we think, little doubt; but whether it would develop itself independently of any local cause, is a question which we do not feel ourselves able satisfactorily to answer. It is not at all improbable that local irritants are the exciting cause; and we are the more inclined to this belief from the fact that in all the cases which have fallen under our observation the teeth were considerably decayed and had previously given rise to pain, and in some instances they were coated with tartar. While, therefore, the character of the affection is determined by some peculiar constitutional tendency and general enfeeblement of the vital powers of the body, it is not unlikely that local irritation is the immediate cause of its development.

Treatment.—The local treatment should consist of acidulated and astringent gargles. The ulcerated parts may be occasionally touched with a solution of the nitrate of silver, or chlorid of zinc, from three to eight grains to the ounce of water; phenol sodique or permangan-

ate of potash solution may be employed to correct the fetor. As soon as the alveolar process exfoliates, it should be removed. After this takes place a cure is generally speedily effected under proper constitutional treatment. This last may consist of mild alteratives, a generous nutritive diet, consisting of succulent vegetables, and, in the absence of fever, of wholesome meats, tonics, and exercise in the open air. (See "Ulcerous Stomatitis.")

ADHESIONS OF THE GUMS TO THE CHEEKS.

The gums and inner walls of the cheeks sometimes contract adhesions which interfere seriously with the functions of the mouth. The affection may be congenital, but in the majority of cases it occurs subsequently to birth. The extent of the adhesion may be small, or it may occupy the gums of the entire alveolar border of one or both sides of the mouth and of one or both jaws. Desirabode relates the case of a young man, who, in consequence of a venereal ulcer, had his upper lip united to the gums of the four incisors in such a way as to form a sort of loop above the teeth, which, by the retraction of the lip, were caused to project outward.

Adhesion of the gums to the cheek or lips results from ulceration, caused either by constitutional disease or local lesions. But that it arises more frequently as a consequence of the immoderate use of mercury than from any other cause is a universally admitted fact. The author has met with several cases, however, in which the affection has resulted from ulceration of the gums around necrosed temporary teeth and of the corresponding wall of the cheek, caused by excoriation of the mucous membrane, produced by the sharp points of the protruding roots. But the extent of the adhesion, in cases of this sort, is never very considerable.

The proper remedy is to separate the parts which have grown together with a sharp bistoury. This done, reunion should be prevented by keeping a pledget of cotton or lint in the wound, until the process of cicatrization is completed.

CHAPTER V.

DISEASES OF THE PERIDENTAL MEMBRANE.

PERIODONTITIS.

Periodontitis, pericementitis, alveolo-dental periostitis, peridentitis, as the affection is variously named, denotes inflammation of the investing or peridental membrane of the roots of the teeth, a tissue highly vascular and very susceptible to inflammatory conditions, and which may, in many cases, be regarded as a premonitory stage of alveolar abscess.

Although the death of the pulp generally precedes the form of inflammation of the peridental membrane which affects the apical space, yet there are other forms of periodontitis which exist independent of the dental pulp; for example,—an acute, non-purulent form which occurs around the necks of the teeth; an acute, non-purulent, circumscribed form which affects one side of the root-membrane, or may encircle the root about its middle portion. There are also other forms of this affection, such as an acute non-purulent form which may originate in and be confined to the apical space; an acute non-purulent form which may arise in the apical space and extend over the greater part of the peridental membrane below the marginal portion; an acute purulent form which involves the apical space only; an acute purulent form which may arise in the apical space as a result of the apical form, and extend over a considerable portion of the peridental membrane. Chronic forms of periodontitis also exist, which differ from the acute forms in the character of their phenomena, which are not so intense as those of the latter. The peridental membrane is confined between the walls of the alveolar cavity and the root of the tooth, and as a consequence is incapable of expansion when its vessels are engorged with blood, and being endowed with a large supply of nerves, which render the membrane very sensitive even in a normal condition, it becomes excruciatingly painful when inflamed.

Inflammation of the peridental membrane of a tooth may therefore be *acute* or *chronic*, the acute forms being generally due to direct local irritation and the chronic forms to the result of the acute forms, or to systemic influences. Each variety is modified in its character by the state of the constitutional health and by the causes concerned in its production, and also its location, extent, etc. The premonitory symptoms of the acute varieties, especially when they are apical or diffuse, are a slight sensation of uneasiness and tension, a feeling of

fullness about the affected part, and a desire to press the teeth together. Pressure appears to afford temporary relief, but the uneasy feeling returns on the pressure being withdrawn.

These symptoms are soon followed by a dull, heavy, and continuous pain, and the affected tooth appears to be longer than the adjoining ones, and is really so, owing to the increased thickness of the investing membrane of the root. Occlusion of the teeth gives rise to severe pain, and there is an inclination to keep the jaws apart. The appearance of the gums at this stage of the affection also indicates the existence of disease in the peridental membrane; they become very tender and swollen, and change from a pale rose color to a deep red or purple opposite the root of the affected tooth.

At first the inflammation is circumscribed, but soon it becomes more general, until the whole of the gum about the root of the tooth is involved. Although the pain increases in severity, it yet preserves the same character, and even when not continuous, it seldom ceases for any great length of time. At length suppuration occurs, and we have the condition known as alveolar abscess, this process sometimes extending to nearly every part of the periosteum, causing the entire death of the tooth, and often followed by erosion of the root and necrosis of the alveolus. When favored by a cachectic habit of body, it often extends to the periosteum of the jaw, followed by suppuration and necrosis.

The inflammation of the peridental membrane has been classified according to its location, symptoms, causes, and results, such as *acute cervical periodontitis; acute circumscribed periodontitis; acute apical periodontitis*, and *acute diffuse periodontitis*. When the inflammation of this membrane terminates in suppuration, such forms, according to their location, causes, symptoms, and results, may properly be classified as forms of alveolar pyorrhea and alveolar abscess.

Acute cervical periodontitis is characterized by an area of bright red gum, corresponding in extent to the area of inflamed peridental membrane about the neck of the tooth. The gum is detached from the neck of the affected tooth to a greater or less degree; and when salivary calculus is present, the margin of the gum assumes a bluish color. The pain resulting from this cervical form is seldom acute, but more frequently consists of an annoying sensation; the tooth is sensitive to pressure, and sometimes to thermal changes, unless the cause is due to salivary calculus, when a soreness instead of a decided pain is experienced about the neck of the affected tooth.

Acute circumscribed periodontitis is usually confined to that portion of the peridental membrane which is midway, or thereabouts, between the cervical and apical portions. This form of the disease may en-

circle the root of the tooth or be confined to the lingual surface of the root. Pressure from the opposite side causes pain, and percussion elicits a dull sound. When due to a local irritant or injury, this form may continue for from one to three days; whereas if it is caused by constitutional derangement, it is liable to assume a chronic character and be more persistent.

Acute apical periodontitis is first characterized by soreness of the tooth, and light redness of the overlying gum. The affected tooth at length becomes loose, and is elevated in its cavity above the level of the adjoining teeth, owing to the thickening of the peridental membrane by the effusion of watery liquid from the blood into the affected tissue. The pain resulting from this apical form is acute and pulsating, and often extends to the entire side of the face, becoming more severe toward evening, especially when the sufferer assumes a recumbent position; active exertion and the use of alcoholic stimulants aggravate the pain. The tooth is also very sensitive to cold, and the gum over the root is quite hot. Mastication is exceedingly painful, and in some cases closure of the jaws is difficult. Percussion elicits a very dull sound in the affected tooth. This acute apical form comes on gradually during one or two days or more before it is fully developed, and may then continue for four or five days, or even longer, when it may assume a chronic character which is indicated by an abatement of the symptoms.

Acute diffuse periodontitis is usually a result of the extension of the inflammation of the peridental membrane from the apical space over the greater portion of the membrane, although it may not involve the cervical portion. While the symptoms of the diffuse form resemble those of the apical form, they manifest themselves with greater severity. The tooth affected with the diffuse form of periodontitis becomes very loose in its cavity, is greatly elevated above the adjoining teeth, and elicits an exceedingly dull sound on percussion; it is also very sensitive to pressure from any direction, and mastication and closure of the jaws are impossible. The gum over the root of the affected tooth is very much swollen and of a dark red color. The pain experienced is of a very severe, throbbing character, and these severe symptoms may continue for three or four days or even a week, when they abate, or the inflammation assumes a chronic form.

Acute inflammation of the peridental membrane having terminated in suppuration, sometimes, instead of subsiding altogether, degenerates into a chronic form, and when favored by some constitutional vice, as the scorbutic, venereal, or scrofulous, it often gives rise to the destruction of the socket and loss of the tooth.

The acute form of periodontitis is readily diagnosed by the pain

caused by pressure on the affected tooth, which distinguishes it from such diseases of the dental pulp as irritation and inflammation or pulpitis. Besides, the pain of periodontitis can always be definitely located, whereas in pulpitis its exact location is often doubtful; again, the dental pulp is influenced by thermal changes to such a degree as to very greatly increase its sensibility when diseased, whereas the peridental membrane is not so influenced, and its sensitiveness is not increased to any marked degree by thermal changes, except when the pulp cavity contains gas, which expands from heat and induces pressure on the tissues beyond the apical foramen.

Chronic inflammation of the peridental membrane is generally preceded by the active form of the disease, but it may assume the chronic form at the commencement. In this case it is complicated with tumefaction of the gums and discharge of puriform matter from between their edges and the necks of the teeth. Chronic periodontitis is therefore but a modified form of the acute, and is manifested by soreness of a tooth, which may either be so slight as to occasion very little annoyance, or be very considerable, with apparent congestion of the gum about the tooth, and sensitiveness of a greater or less degree when the organ is pressed upon.

After the loss of vitality in the pulp of a tooth, the peridental membrane is very susceptible to inflammation, owing to the irritation to which it is subjected, and also to the weakened condition of this membrane and its increased function in supplying the cementum and dentine with nourishment.

Causes.—Acute cervical periodontitis is caused by chemical and mechanical irritants, such as decomposing food and other matters retained about the neck of a tooth, and in connection with the peridental membrane; also the bristles of tooth-brushes, small particles of bone, and other foreign substances forced under the gum in mastication, etc.; also improperly fitting bands, metal crown-caps, overlapping fillings, and salivary calculus.

Acute circumscribed periodontitis is the result of mechanical injury or of constitutional derangements, the latter cause being first noticed in a former edition of this work.

Acute apical periodontitis is of frequent occurrence, and is generally the result of pulpitis caused by chemical and mechanical irritants. A putrescent or gangrenous condition of the pulp of a tooth is a common cause of this form of the disease; also filling materials and irritating agents used for disinfecting and antiseptic purposes, forced through the apical foramen into the apical space; broken nerve instruments; metallic fillings built too high upon the grinding surfaces of a tooth; too rapid wedging and too rapid regulating of teeth; severe malleting;

improperly filled cap-crowns and bridge-work, and badly antagonized artificial teeth exercising undue pressure on a natural tooth.

Acute diffuse periodontitis is caused by inflammation of the pulp, chemical and mechanical irritation of the membrane lining the apical space, and constitutional derangements. Acute pulpitis and a putrescent condition of the pulp are frequent causes. Inflammation of the pulp from any cause may involve the peridental membrane of the apical space and thus establish periodontitis.

Constitutional derangements may consist of a syphilitic taint through an infiltration of lymph and serum into the peridental membrane, or between it and the root of the tooth or alveolar walls of the socket; also rheumatism, especially in those who have been subjected to an excess of mercury, and also scrofula. This affection may also extend from the peridental membrane of one tooth to that of adjoining teeth.

Treatment.—The treatment of the different forms of periodontitis will depend upon the location, the causes producing and influencing the disease, and the condition of the general system.

The treatment of the *acute cervical* form consists in the removal of the irritant, the disinfection of the mouth, and the use of an astringent or antiphlogistic lotion.

The mouth may be disinfected by pyrozone (30 per cent. solution) in the form of a mouth wash, or by iodoform, iodol, eucalyptus, iodin, europhen, salicylic acid, glycozone, listerine, resorcin, and a number of other disinfectants and antiseptics all in proper solution.

The treatment of the *acute circumscribed form*, when originating from mechanical violence, consists in the application of antiphlogistic lotions, of which the following is an example:—

℞.	Plumbi acetas, ...	ʒj.
	Tinct. opii, ...	℥ss.
	Aquæ, ...	℥viij to x.

SIGNA.—Apply as a lotion on lint or cotton to the gum surface about the affected roots.

When this form of periodontitis is due to other causes, the local application of equal parts of tinct. of iodin and tinct. of aconite will prove serviceable. When depending upon constitutional derangements, constitutional treatment for the particular disease present is indicated.

The treatment of the *acute apical form* of periodontitis when this form of the disease is due to external violence or irritation, consists in the removal of the irritant and the application of antiphlogistic or counter-irritant applications. The antiphlogistic combination of

acetate of lead, tincture of opium, and water, or the counter-irritant combination of aconite and iodin often prove serviceable.

When due to pulpitis or to foreign substances forced through the apical foramen or the side of the root of the tooth, the prognosis is more unfavorable, and the destruction of the vitality of the pulp and its complete removal, or the removal of foreign matters from the pulp canal and the use of disinfectants, is necessary.

The treatment of the *acute diffuse form* of periodontitis is similar to that of the acute apical form, and the prognosis is yet more unfavorable for the preservation of the vitality of the pulp. This form is very prone to degenerate into a purulent inflammation, when it may be classed as alveolar abscess, the treatment of which demands the opening of the apical foramen by means of a fine broach, and entrance into the abscess to evacuate the pus, followed by the proper disinfectant and antiphlogistic treatment and the filling of the pulp-canal and crown-cavity of the tooth.

The first thing to be attended to in cases where the prognosis is unfavorable to the preservation of the pulp is its devitalization and the removal of all irritants from the pulp-cavity, such as an inflamed or decomposing pulp, after which the congestion of the affected part may be relieved by the use of such agents as produce counter-irritation, or by depletion.

When the pulp of the tooth is inflamed it should receive immediate attention, and when the pulp is dead, all the debris should be removed from its pulp-cavity by means of nerve instruments and syringing with tepid water. All deposits of calculus should be removed from the teeth, and also all dead teeth and roots which are useless and cause irritation, should be removed from the mouth. The pulp-cavity should then be thoroughly disinfected by iodoform, or eucalyptus, iodin, carbolic acid, salicylic acid, sanitas, etc. After the application of the disinfecting agent, the pulp-cavity should be loosely filled with cotton saturated with an antiseptic agent, but sufficiently close to prevent the entrance of fluids. If a secretion of pus is present the application may be frequently changed, and thus prevent the pressure of the secretion from causing pain. In severe cases where the above treatment does not prove effectual, counter irritation may be resorted to; the gums may be scarified, or such agents be applied as iodin and creasote, tincture of capsicum, and tincture of iodin. An excellent application is composed of equal parts of the official tincture of iodin and tincture of aconite root applied to the gum two or three times daily, in the acute form of the affection. Previous to the application, the gum should be dried, and afterward the cheek kept from coming in contact with it

until a metallic pellicle is formed. Cantharidal collodion is also an excellent counter-irritant, and is applied to the gum, after the surface is dried with a napkin, by means of a camel's-hair brush, taking care to protect the lip, and to prevent moisture from interfering before the ether in the preparation evaporates and an artificial cuticle is formed. Within a few hours blistering results, and the periodontitis is effectually relieved. Another method of producing counter-irritation is to make a deep incision in the gum over the affected root, and to introduce into this a small pellet of cotton or lint saturated with creasote or carbolic acid, which is retained for from one to five days, the time depending upon the persistence of the inflammation, taking the precaution to change the dressing every day. The application of a solution composed of equal parts of tincture of aconite, tincture of opium, and chloroform, is often very serviceable ; also a small linen bag containing capsicum, one side of the bag being covered with leather, to protect the cheek. Lead-water, in the proportion of a fluidounce to two fluidrams of laudanum, applied in the same manner as the agent before named, has also been successfully used. Depletion may be accomplished by means of the gum lancet, or by the use of leeches or cups.

Hypodermic injections of morphine have also been resorted to for the relief of the intense pain of this affection, such as a solution of morphine or tincture of opium, some ten to twenty drops of the latter being injected with a suitable syringe beneath the mucous membrane ; also, with good effect, the application of rhigolene or ether spray until the gum about the affected tooth is blanched. As a topical application, rhigolene has been recommended, applied to the gum on a pellet of cotton after free scarification.

Constitutional treatment is also serviceable, such as the administration of saline cathartics. Bromid of potassium in a dose of twenty-five grains, or the same quantity of the bromid combined with five drops of the tincture of veratrum viride, and repeated every four hours, will often prove serviceable in incipient alveolar periodontitis. A preparation known as *mercurius vivus*, the third decimal trituration, given in small doses two or three times a day, has been recommended by Prof. Chase and used successfully by others in relieving acute periodontitis. During the treatment, a cap of gutta-percha, molded to the crowns of one or two teeth on the opposite side of the jaw, will protect the affected tooth from any irritation which may be caused by the occlusion of the opposing ones, and thus facilitate the restoration. For the treatment of the chronic variety of periodontitis, the reader is referred to "Chronic Inflammation and Tumefaction of the Gums."

ALVEOLAR ABSCESS.

An alveolar abscess is a collection of pus in a sac attached to and closely embracing the root of a tooth, and is the result of inflammation of the tissues of the apical space, where its inception invariably occurs. The peridental membrane having become the seat of acute inflammation, plastic lymph is effused at the extremity of the root. This is condensed into a sac or cyst, which closely embraces the root near its apex, the walls of lymph become vascular, and perform the functions of secretion and absorption, and as suppuration takes place, pus is formed in the centre of the sac. The inflammation in the meantime having extended to the gums and neighboring parts, they swell and become painful, and as the pus accumulates in the sac, it distends and presses upon the surrounding walls of the alveolus, which, by a chemico-vital process, are gradually broken down. By absorption, through pressure, an opening is ultimately made through one side of the alveolar cavity, when the pus, coming in contact with the investing soft structures, presses upon them and causes their absorption also, or it may follow the side of the root to the margin of the gum, and thus outlets are effected for the escape of the accumulated matter.

In some cases the pus may separate the periosteum from the bone of the alveolar cavity and form a receptacle for itself between the membrane and alveolar wall, and if not promptly discharged may cause necrosis of the bone.

The pus of an alveolar abscess, in the case of young persons, usually finds an exit through the root canal of the tooth, especially when the abscess is formed upon the apex of the root, owing to the large size of the foramen of a deciduous tooth. In adult persons the escape of the pus generally takes place through the alveolar wall and the soft tissues opposite the root of the affected tooth.

The secretion of an alveolar abscess, especially when an inferior molar is affected, may find its way to the surface of the cheek or neck, and considerable deformity be caused from the cicatrix resulting. In some cases the sinus of an abscess may invade the duct of a salivary gland and necessitate the operation for salivary fistula before a cure can be effected; but the secretion may escape from a more remote point. It may make for itself an opening through the cheek or through the base of the lower jaw, and be discharged externally; or it may pass up into the maxillary sinus, or through the nasal plate of the superior maxilla, or form a passage between the two plates of the bone, and escape from the centre of the roof of the mouth.

The formation of abscess in the alveolus of an inferior dens sapientiæ is sometimes attended with inflammation and swelling of the ton-

sils and of the muscles of the cheek and neck. The author has known trismus to result from this cause.

The pain attending the formation of alveolar abscess is deep-seated, throbbing, and often so excruciating as to be almost insupportable. But as soon as suppuration takes place, it loses its severity, and with the escape of the pus nearly or altogether ceases; but the tooth, from the thickened condition of the peridental membrane particularly at the apex of the root, often remains sore and sensitive to the touch for several days. The energies of the disease, however, having been expended, the secretion of the pus in the majority of cases wholly ceases, and the opening in the gums closes. From the increased susceptibility of the peridental membrane to morbid impressions, occasioned by the presence of a tooth deprived of a large portion of its vitality, a recurrence of the inflammation is liable to take place, when pus will be again formed and the passage for its escape re-established. But the pain attending any subsequent attack is seldom so severe as in the first instance.

There are some cases, however, in which the inflammation, instead of subsiding altogether, degenerates into a chronic form of abscess. In this case, the sac at the extremity of the root continues to secrete pus, though the quantity is usually small, and the opening in the gums remains unclosed.

Persons of a scrofulous diathesis are very liable to this affection, which, in these cases, very soon assumes a chronic form.

In the extraction of a tooth which has given rise to the formation of abscess, the sac is often brought away with it. Two teeth in which this had happened, taken from the upper jaw—one a cuspid and the other a first molar—are represented in the accompanying cut (Fig. 120). In the case of the molar the sac is attached to the palatine root. Both of these teeth were extracted previously to the formation of an external opening for the escape of the matter.

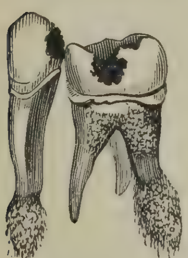


Fig. 120.

Although in the majority of cases the sac is attached to the apex of the root, yet it is not unusual for the point of attachment to be on the side of the root, as in the case of the superior front teeth and bicuspids, or in the bifurcation of the roots, in the case of the molars, for example. When the sac is situated upon the side of the root of a superior front tooth, it is generally upon the labial surface, and when it is situated at the apex of the root of a molar tooth the palatine root is the one generally affected. The temporary teeth are much more liable to this disease than the permanent teeth, and the

superior incisors more susceptible than the inferior teeth of the same class.

But the treatment of inferior teeth affected with abscess, especially the bicuspids and molars, is often more difficult than that of the superior, on account of the gravitation of the pus and the impossibility in many cases of making an opening through the alveolar process so low as the extremity of the root, owing to the muscular attachment being so high on the ridge.

The character of the secretion differs considerably in different cases ; instead of the yellowish-white appearance that pure or laudable pus presents, and which may be present in some cases of alveolar abscess in good constitutions, a highly vitiated, acrid fluid, with either a diminished supply of pus corpuscles or an entire absence of such corpuscles, usually distinguishes the secretion, which sometimes becomes very irritating in its effect upon living tissue. The systemic condition of the patient modifies the character of the secretion, as also does the nature of the local irritants.

The time required for the formation of alveolar abscess varies from three to ten or fifteen days, according to the violence of the inflammation. But a collection of pus may be detected by fluctuation under the finger, if applied to the tumefied gum one or two days before an external opening is spontaneously formed for its escape.

The size of the cavity formed by an alveolar abscess depends upon the severity of the disease and the susceptibility of the parts involved. In some cases it is quite small and confined to the point of irritation, while in others it may be very extensive. Very severe pain accompanies this affection when the abscess is rapidly formed, owing to the distention occasioned and the inability of the secreting pus to escape. As soon as an opening is effected, however, the tension is relieved and the pain subsides. A great susceptibility to alveolar abscess exists in case of an inflammatory diathesis, and after a time it may assume a chronic character, when the secretion and discharge of the pus is continuous. Although the pain of chronic abscess may not be more than a slight uneasiness, the acute form is productive of intense pain. There is also a difference in the extent of the inflammation affecting neighboring tissues, depending upon the activity of the irritants present, and in some cases of alveolar abscess the inflammation of adjacent parts may be very limited, while in others it may be very extensive.

The inflammation and pain attending the formation of abscess in the alveolar cavity of a tooth often give rise to general febrile symptoms, headache, and constipation of the bowels. In the acute form of this disease the pain is intense, while in the chronic form, where the

pus is constantly secreting and discharging, the sensation experienced is soreness and an uneasy feeling, with a slight pain upon a change of temperature.

Chronic alveolar abscess generally follows the acute form, and results from a subsidence of the acute symptoms into others less painful, but more persistent. The chronic form is generally accompanied with a fistulous opening which, in its position and the direction of the canal, presents quite a variety of forms. The fistulous opening is usually, however, upon the gum over the root of the affected tooth ; but in some cases the fistulous opening may close and the secretion from the abscess appear at a different point some distance from the original one. In other cases a chronic abscess may again assume acute symptoms, which may continue until a new exit for the secretion manifests itself at a more remote point. These chronic cases often cause a feeling of stiffness, caused by the pus burrowing through muscular tissue, as the secretion will generally follow a course which presents the least resistance. The direction of the pus is also influenced by gravitation, especially in abscesses connected with the inferior teeth. Abscesses connected with the inferior molar teeth sometimes discharge into the antrum and produce serious complications. Abscesses discharging on the face are generally connected with the inferior molar teeth and are influenced in this respect by gravitation, and the least resistance the pus in its burrowing course may meet with. The closure of a fistulous opening of a chronic alveolar abscess may lead to the retention of the pus, which, on account of gravitation, in the case of an inferior tooth, penetrates to the surface along the border of the lower jaw. Abscesses connected with the superior teeth, when pointing on the face, generally discharge beneath the prominence of the malar bone, and the deformity resulting after the healing of the fistula is caused by the formation of a dense cord of new tissue which binds the skin permanently to the bone, and which must be severed in the treatment for correcting such a deformity.

Causes.—The immediate cause of alveolar abscess is inflammation of the peridental membrane, which is frequently incited by inflammation of the pulp and its subsequent death and decomposition, irritating matter being thus formed, which sooner or later affects the tissues of the apical space through the apical foramen of the tooth. Such a condition is often the result of filling the cavity in the crown of a tooth, and permitting a dead and decomposing pulp to remain in the pulp-cavity. It may also be produced by mechanical violence, the irritation of a dead tooth, or by a drill accidentally passing from the canal through the side of the root into the peridental membrane, or by the

presence of a portion of a filling, a broken broach, or other foreign matter, or irritating medicinal agent, forced through the root of a tooth.

Treatment.—The treatment of alveolar abscess should be preventive rather than curative, for it often happens, after it has occurred, that the integrity of the parts is so impaired as to cause a recurrence of the affection. Although the secretion of pus may cease for a time, and the opening in the gums become obliterated, the tooth, being deprived of a large portion of its vitality, is liable, whenever the excitability of the peridental membrane is increased by any derangement of the general system, to give rise to a recurrence of the disease. Especially is this the case when the disease has assumed the chronic form. The formation of an abscess, therefore, should, if possible, be prevented by the use of such means as are referred to in the treatment of "periodontitis," a common termination of this disease being alveolar abscess. But should these means fail to prevent the formation of pus, we then have to resort to either therapeutic or surgical treatment, consisting in the removal of the irritant matter from the pulp-cavity.

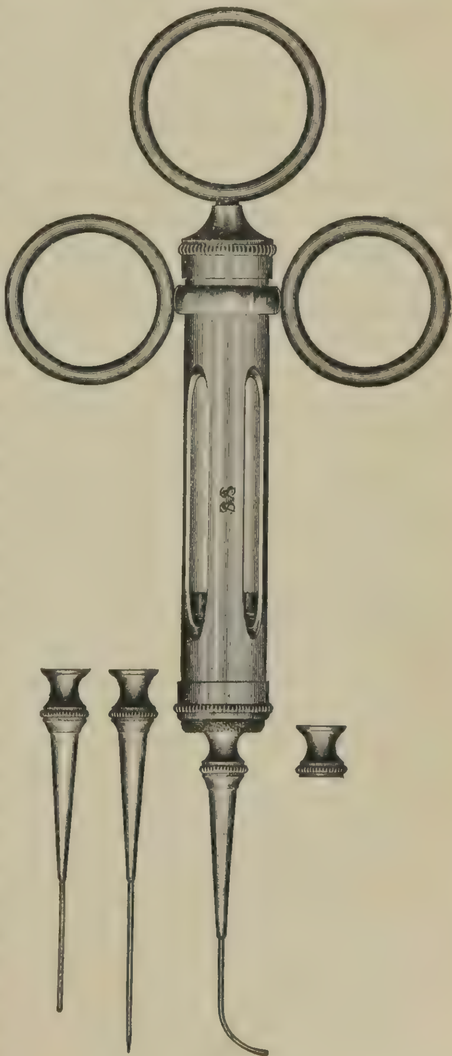


FIG. 121.

An alveolar abscess of recent origin will yield more readily to treatment than one of long continuance, and the chronic form is much more difficult to arrest, especially after the adjacent parts have become involved, than the acute form.

When constitutional derangement is present, general treatment, such as the particular condition indicates, must be resorted to. The local or surgical treatment consists in breaking up the sac of the abscess, and the evacuation of the pus as soon as possible, and ready access must be had to the point of accumulation in order to successfully accomplish such a result.

A sharp-pointed bistoury or small trephine may be employed to enlarge the fistulous canal when the pus has made an opening through the process and gum to the surface opposite the root of the tooth, and the sac broken up by means of nerve instruments, its remains being thrown off and healthy granulations developing without further treatment. In many cases, however, therapeutic treatment must follow the surgical before a perfect cure is accomplished. The therapeutic treatment consists in first removing all irritating substances from the pulp-cavity, which should be freely opened to the apex of the root, and the application of disinfectant and antiseptic remedies. For cleansing the root, peroxid of hydrogen, chlorid of sodium, etc., injected into the canal answers a good purpose, to be followed by such agents as will cause the absorption or destruction of the sac secreting the pus, such as creasote, carbolic acid, mercuric chlorid, followed by alcohol, peroxid of sodium, salicylic acid (applied in the solid form), nitrate of silver, iodin, etc. When a tumor appears on the gum from the presence of the pus which has penetrated the bone, the contents of the abscess should first be discharged by making an opening in the tumefied gum with a sharp lancet, provided the disease has been allowed to progress to such a degree as to render this operation necessary. The opening in the gum should not be allowed to close until the pulp cavity has been exposed and the decomposed contents removed, when this cavity should be thoroughly disinfected by such agents as mercuric chlorid, followed by alcohol, peroxid of sodium, iodoform, iodol, aristol, sulphuric acid, etc., etc. If no opening has been formed through the alveolar process the decay in the crown cavity should be removed, and the orifice of the pulp canal be so enlarged as to admit a nerve instrument or small broach, by means of which it can be cleaned out, and thus allow the matter to escape through the tooth. Tepid water should then be injected into the pulp canal by means of a small syringe, until all decomposed matter is removed, when one of the remedial agents mentioned above may be substituted for the tepid water, or applied on a strand of floss silk, which is carried to the apex of the root by means of a nerve instrument or broach. At the end of twenty-four or forty-eight hours, according to the character of the symptoms, this treatment is repeated, the crown cavity during the interval being filled with cotton. A

combination of several of the remedial agents is serviceable in obstinate cases, such as creasote and tincture of iodin, carbolic acid and tincture of iodin, or creasote and tannin in alcohol, aristol and chloroform, iodoform and eucalyptol, etc., etc., which can be applied on floss silk, introduced daily for two or three days, until the discharge ceases.

Fig. 121 represents an abscess syringe, of improved form, with two gold points—straight and curved—and one hypodermic point. The metal case is slotted to expose the glass barrel, and provided with finger-holds.

The application of the vapor of crystals of non-agglutinized iodoform, as recommended by Dr. Peabody, so that it may be forced into the canal, thoroughly permeating it and filling the tubuli, a precipitate being thus deposited which forms a solid, insoluble filling, is also very effective. The cylinder of a hot-air syringe is partly filled with the crystals and heated over a flame until they are fused. This vapor also penetrates the apical foramen and subdues the irritation and inflammation of the peridental membrane.

The following solution of Dr. Percy Boulton possesses therapeutic virtues of superior efficiency, especially after creasote, carbolic acid, eucalyptus, iodoform, iodin or salicylic acid have been employed to stimulate and disinfect the secreting surfaces to a healthy action :—

℞.	Tr. iodin comp., ...	♏xiv.	
	Acid. carbolic. cryst. (fusa), ...	♏vj.	
	Glycerinæ, ...	ʒ viij.	
	Aq. destillat., ...	℥ v.	M.

This solution possesses antiseptic and stimulant properties.

The surgical treatment consists in making an opening, or enlarging the fistulous one, through the alveolus, opposite the extremity of the affected root, by means of a small trephine, drill, or chisel, first making a vertical incision in the gum with the lancet, and thus gaining access to the seat of the disease. The attachment of the sac to the root is then broken up by means of a delicate instrument which permits of being passed about the extremity of the root, and the wound in the gum kept open for a few days by inserting a tent, in order that the remains of the sac may escape, and such agents as tannin and glycerin, carbolic acid and glycerin, etc., or the Boulton formula, may be applied. It rarely happens that this surgical treatment can be made through the pulp canal of the root and without an opening in the alveolar process. During treatment, to prevent the occlusion of the teeth, where this may be necessary, a cap of gutta percha can be molded over the adjoining teeth by first softening this material in warm water.

The excision of the apices of the roots of teeth, by means of a small trephine, and thus bringing away the sacs also, has been recommended as successful surgical treatment of alveolar abscess.

Dilute aromatic sulphuric acid is a very reliable application, either alone or combined with a small quantity of tincture of capsicum, in chronic cases of alveolar abscess of long standing associated with a necrosed condition of the margins of the processes. The use of sulphuric acid is also recommended for opening root-canals to gain access to the pus-sac.

Replantation is also resorted to, and in many cases may prove efficient, if care is exercised to remove all coagulated lymph and diseased membrane, and also to fill the canal permanently before returning the tooth to its cavity. Under favorable circumstances a tooth thus treated may become firmly attached within a few days.

When escharotic agents are injected into the pulp-cavity and through the fistulous opening in the process and gum, their contact with the mucous membrane may be prevented by applying the rubber dam, or by the introduction of a Hill's stopping filling in the crown cavity, in the center of which an opening is made to admit closely the point of the syringe, while at the same time the parts about the fistulous opening are protected by bibulous paper, cotton, and napkins. When there is a tendency of the accumulated pus in the sac of an abscess upon one of the inferior teeth to discharge through an external opening in the cheek, or beneath the jaw, this result may be prevented by a free incision in the gum opposite the root of the affected tooth; should the discharge, however, through an external opening be inevitable, the immediate extraction of the tooth is necessary.

The application of fomentations and emollient poultices externally are rarely productive of any advantage, and may do harm by promoting the discharge of matter through the cheek or lower part of the face. When this occurs a depression, with puckering of the skin, is apt to remain after the escape of pus through the opening ceases and the orifice has closed, causing disfiguration of the face, which is caused by the formation of a strong cord of new tissue which binds the skin firmly to the bone.

It rarely happens, however, that anything more is necessary for the cure of the external opening than the extraction of the tooth which has given rise to the formation of the abscess.

The formation of an abscess in the alveolus of a lower wisdom tooth is sometimes productive of very serious and even alarming consequences, such as obstructed deglutition, fever, difficult respiration, rigidity of muscles of jaw, and inability to open the mouth.

The late Prof. Thomas E. Bond recorded the case of a superior cen-

tral incisor affected with a chronic alveolar abscess where the discharge of pus occurred from behind the curtain of the palate, and which ceased on the removal of the affected tooth after continuing for over twelve months ; and another case was recorded by Prof. Chapin A. Harris, where the discharge of pus from an abscessed superior first molar passed up into the posterior nares, and found exit behind the velum palati.

Inflammation of the investing membrane of the roots of an inferior dens sapientiæ may produce equally serious effects, without occasioning the formation of an abscess in the alveolus. The eruption of these teeth is sometimes attended with like consequences. The irritation has, in some instances, extended to the lungs, and even been, in such diatheses, the exciting cause of consumption.

The occurrence of alveolar abscess in the cavity of a temporary tooth is often followed by exfoliation of the sockets of several teeth, and sometimes of considerable portions of the jaw-bone, seriously injuring the rudiments of permanent teeth and sometimes causing their destruction. The author saw a case, a few years since, in which an abscess of the alveolus of the first lower temporary molar had occasioned exfoliation of the sockets of a cuspid and two molars. About one-half of the alveolar cells of the two bicuspids and the cuspid of the second set were also exfoliated, thus leaving their imperfectly formed crowns entirely exposed.

The treatment of the chronic form of alveolar abscess is generally confined to the removal of the cause of the affection, or at least to that of the secretion, which in simple cases consists in the cleansing of the pulp-cavity of all irritating matter, which by its decomposed condition promotes the formation of pus. The application of disinfecting agents is then indicated, such as peroxid of hydrogen, mercuric chlorid followed by alcohol, peroxid of sodium, eucalyptus, iodoform, iodin carbolic acid, salicylic acid, etc.

Peroxid of hydrogen or sulphuric ether answer as good cleansing fluids in the form of injections by means of an abscess syringe. The entire tract of the abscess and fistulous opening should be subjected to the action of the disinfectant. Dr. G. V. Black has successfully employed a combination of carbolic acid two parts, oil of cinnamon one part, and oil of gaultheria three parts, in the form of an injection as a stimulant disinfectant. The presence of sanguinary calculus on the root of a tooth affected with the chronic form of alveolar abscess may retard or prevent the successful treatment until such an irritant is removed.

ALVEOLAR PYORRHEA.

Alveolar Pyorrhea, commonly designated "Riggs' disease," denotes suppurative inflammation of the gums and peridental membranes, attended with the destruction of the alveolar processes. It usually commences with an uneasy sensation in the gums and teeth, which soon become painful.

At an early stage of this disease the margin of the gum presents decided inflammatory action and bleeds from slight causes.

As the disease progresses, the inflammation extends deeper into the substance of the gum, which becomes greatly congested with venous blood, swollen, and exhibits a tendency to separate from the necks of the teeth, which gives rise to the formation of small sulci filled with pus. There is also a loss of substance of the gum, and the destruction of the margins of the alveolar processes is followed by the death of the thicker portions beneath, and, as a consequence, the teeth become loose and change their positions. There is frequently a separation and protrusion of the superior and inferior front teeth, with a thick, fetid discharge from about their necks, which causes a disagreeable taste and a very offensive breath. The gum at this stage of the disease is of a dark purple or livid hue, with a congested margin, and in some cases, on account of its being denuded of its epithelium, its surface presents a polished appearance; it may also become granular and covered with fungous excrescences. At an extreme stage of the disease, complete destruction of the alveoli and of a considerable portion of the gum occurs, and the teeth are held in place by a tough, ligamentous attachment, which was formerly the peridental membrane. The roots of the teeth become coated with a layer of calculus, often of a greenish-brown color and great hardness, which adheres tenaciously, rendering its removal very difficult.

Although the two forms of calculus, the salivary, which is derived from the saliva, and the sanguinary, from the serum that exudes from the gums when diseased, cause inflammation of the peridental membrane, yet the latter form of calculus appears to be more commonly associated with this suppurative inflammation than the former.

The congestion and consequent recession of the gum from about the necks of the teeth permits the salivary form of calculus to be deposited on the roots, by the ready access afforded to the fluids of the mouth; while the pathological condition of the tissues in connection with the teeth causes a serous exudation, the result of which is the deposit of the harder variety of calculus.

The nature of this calcic deposit is no doubt modified by the serous fluid from the gum.

Causes.—Although one form of alveolar pyorrhea is a disease which may depend almost wholly upon local causes, such as the irritation of salivary and sanguinary calculus, and especially this latter form of calcic deposit, and a perverted condition of the secretions, yet the peculiar manifestations of another form often depend upon some unfavorable diathesis, which enables the local causes to produce more serious effects than might be possible in better systemic conditions. If the teeth are perfectly free from irritating accretions, and present smooth, polished surfaces at points where the more highly vitalized surrounding structures come in contact with them, no inflammatory action will occur in such structures. On the other hand, if the teeth, on account of calcic deposits about the margin of the gum and along their roots, act as irritants, inflammatory action, followed by such effects as one form of the disease under consideration presents, may ensue. And again, if a gouty diathesis is present due to a superabundance of uric acid in the system, the aggravated symptoms of another form of this affection manifest themselves. Low vitality and all diseases which affect the circulation may be named as predisposing causes of alveolar pyorrhea.

Dr. Black, in describing this disease under the title of "phagedenic pericementitis," maintains that it is of local orgin, while Dr. Atkinson ascribes it to constitutional causes. There is good reason, however, for believing that there are both predisposing and exciting causes for this disease. Prof. C. N. Peirce believes that it is principally due to a gouty diathesis of the system, and he defines two forms of this affection: in one the origin of the calcic salt is the saliva, and in the other the blood. The former he designates as *ptyalogenic calcic*, its origin being local and salivary; the latter *hematogenic calcic*, its origin being constitutional, and associated with some modifications of the normal composites of the blood plasma. The calcic pericementitis may have its origin at the gingival border, the salivary calculus acting as a local and mechanical irritant with such concomitants as irritation, inflammation, suppuration, absorption of gum and alveolar process. He says: "We have three distinct abnormal conditions affecting the gums, peridental membrane, and alveolar processes. The first is gum inflammation and destruction, caused by a mechanical irritant; second, inflammation of the gingival borders without the presence of salivary calculus. The third is pericemental irritation commencing at or near the apical extremity of the root, due to the presence of some morbid composite of the blood exuded with the plasma and infiltrating the peridental membrane, and frequently deposited or precipitated upon the root of the tooth near its apex. This latter I designated true pyorrhea alveolaris, or hematogenic pericementitis, and so in-

timately is it associated with some other local manifestation of a gouty diathesis, that I believe it to be another local expression of that systemic condition." That a superabundance of uric acid in the system may assist in producing alveolar pyorrhea is the general opinion, but from the fact that uric acid may be present in the system without producing either gout or rheumatism, Drs. Bödecker, Darby, James, Truman, Rhein, and others dissent from the views of Dr. Peirce and assert that uric acid will not exert more influence in producing alveolar pyorrhea than consumption, anemia, kidney and liver affections, syphilis, chronic nervous diseases, etc., which are often associated with alveolar pyorrhea; and they assert that the cause of this disease is a more or less chronic general ailment and not due to any particular form; also that many cases of alveolar pyorrhea can be attributed to nothing but heredity.

Treatment.—In the early stage of alveolar pyorrhea all calcic deposits should be carefully removed and the surfaces beneath well polished; a decided change for the better may occur in a very short time, as the inflamed gum will lose its congested appearance, and assume a lighter color and a firmer consistence, and become reduced to its normal thickness. In the more advanced stages of this disease the treatment consists in reaching, by means of narrow, sharp instruments, the extreme limits of the diseased action, removing all deposits, and breaking up the diseased tissue and necrosed bone, and polishing the surfaces roughened by depositions of calculus.

The diseased margin of the alveolar process must be removed to such an extent that the firm and resistant bone is reached by the edge of the cutting instrument, which a nice sense of touch will determine.

A nice sense of touch, only acquired by practice, will enable the operator to distinguish, with the instrument, foreign and dead substance from tooth structure and living bone. It is especially necessary that every particle of calculus and necrosed bone should be removed, as their presence will be indicated by a reddened patch of tissue, somewhat larger than the irritant beneath. As the removal of such irritants causes both pain and hemorrhage, such an operation will require several sittings and the frequent application of carbolic acid by means of a properly shaped piece of orange wood. After this operation is completed an application of dilute aromatic sulphuric acid will prove serviceable. The effect of such treatment is to promote the reproduction of new bone, and cause the gum to become firmly attached to it, and thus restore the stability of the teeth, and in many cases the only after therapeutic treatment necessary will be the use of an astringent wash, such as tincture of myrrh in its full strength, applied to the gum about the neck of the teeth. When constitutional disturb-

ance exists in connection with the local effects, after perfectly removing all irritants a dilute solution of chlorid of zinc may be applied to the ulcerating surfaces by passing it under the gum, about the necks and roots of the teeth, by means of cotton wound on a broach, and alternating with dilute aromatic sulphuric acid and tincture of iodin, applied to the surface of the gum. Chlorate of potash solution should be used as a mouth-wash after each meal and at night, with as thorough use of the brush as the condition of the gums will permit. The use of a solution of common salt is recommended during the intervals between the applications of the more powerful remedies; also phénol sodique.

For the worst stage of this disease, where the teeth are held in the mouth by means of the tough, ligamentous attachments only, their removal is inevitable.

The illustration (Fig. 122) represents Dr. J. M. Riggs's set of instru-

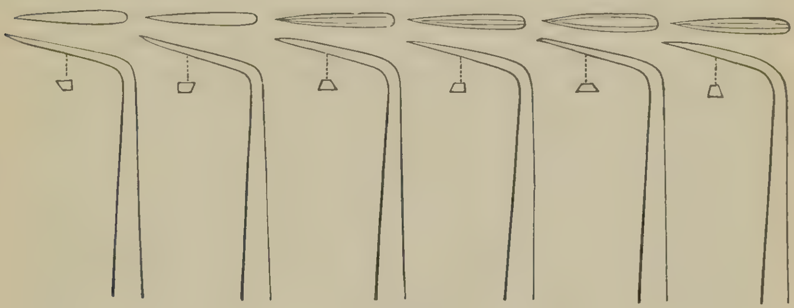


FIG. 122.

ments for the thorough removal of all salivary, sanguinary, and other deposits from the roots of the teeth, in the treatment of this disease.

Some prefer instruments with slender points, which require a pushing motion, instead of the curved hook or hoe-shaped instruments so commonly used for the removal of calcic deposits from the teeth, and which necessitate a motion toward the hand.

Whatever form of instrument is used, the thorough removal of all concretions from the teeth is absolutely necessary in this treatment, as all soft tissues are rendered unhealthy by the contact of calcic deposits. Dr. Cushing's set of scalers (Fig. 123) are well adapted for the removal of all calcic deposits from the teeth.

For the removal of slight deposits in the form of thin scales, Dr. Gilmer recommends that the gum be first expanded, so that it may stand off from the tooth, by packing under its free margin salicylized cotton, which is allowed to remain for twenty-four hours.

A method of treatment recently recommended by Dr. A. W. Harlan is as follows: For the acute form, the pockets formed by the separation of the gum should be first filled with iodoform and eucalyptus, iodoform and oil of cinnamon, or be thoroughly syringed with a one to three-grain solution to the ounce of water of chlorid of alumina, which is a good disinfectant and astringent. In three or four days the sanguinary deposits may be removed, as well as the edges of the alveoli. The pockets should then be syringed with peroxid of hydrogen, for the purpose of thoroughly cleansing them and also to destroy the micro-organisms present. After drying the gums the pockets should be injected with a solution of iodid of zinc, grs. xij to grs. xiv to the ounce of water, two or three drops or more to each pocket. After several days have elapsed the gums should be carefully dried, and a fine cone of cotton or bibulous paper moistened with peroxid of hydrogen gently pressed into each pocket; if any pus is present effervescence will take place, when each pocket must be again injected with the iodid of zinc solution. In chronic cases, after the removal of the diseased bone and the careful cleansing of the roots, the pockets should be syringed with peroxid of hydrogen, followed by the injection of a xxiv gr. solution of the iodid of zinc, in the same manner as before described. In very bad cases a stronger solution of the iodid of zinc is recommended, xxviij grs. to the ounce of water; and when the margins of the gums present a ragged border or cone-shaped slit, pure granular iodid of zinc is applied to the edges of the slit once in three days, the injection into the pockets being repeated every fourth day. Combinations of iodoform and eucalyptus, iodoform and oil of cinnamon, iodoform and eugenol, chlorid of aluminum in the form of a solution composed of one to three grains to the ounce of water, sanitas, three parts to one part of eugenol, peroxid of sodium, have also been employed with benefit, in the form of paste and injections.

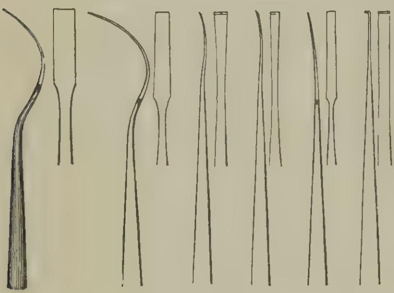


FIG. 123.

A strong solution of chlorid of zinc, 20 to 30 per cent., applied with care about the teeth by means of an abscess-syringe, will prove beneficial by relieving the congestion and constringing the soft tissues. The after-treatment consists in the use of stimulating applications, such as cinnamon-water, or carbolic acid combined with oil of cinnamon and oil of gaultheria, in the proportion of one dram

of the former and four to five drams each of the latter. Cleanliness should also be observed, and in the use of the tooth-brush the motion should always be lengthwise instead of across the teeth—a soft brush being preferable to a stiff one. It is advisable, in cases where the destruction of the alveolar process has not been great, to preserve the gingival margin, in order that a perfect restoration of the peridental membrane may take place. Such an operation may be performed by introducing through the gingival aperture a bent chisel, or a hoe-shaped excavator, and the diseased structure removed as high up as it may extend toward the apex of the root. In cases where the cutting instrument cannot be introduced in such a manner without injury to the gingival margin, a flap of the soft tissue over the diseased bone may be raised, and all carious structure removed, as well as calcic deposits from the denuded root, through such an opening, without destroying the gingival margin. After the parts are thoroughly cleansed by injections of tepid water, stimulating applications may be made of carbolic acid (in crystals) one part, oil of cinnamon two parts, and oil of gaultheria three parts. Dr. Gilmer recommends for obstinate cases the use of carbolic acid and camphor, in the form of "phénol camphor," which consists of equal parts of carbolic acid and gum camphor, prepared by melting such a mixture on a sand bath until an oily liquid is obtained; it is applied by means of a syringe to the pus-pockets. Before the application of disinfectants and antiseptics, the parts should be cleansed with the peroxid of hydrogen, either alone or combined with the bichlorid of mercury, pyrozone 5 per cent. solution, or solution of peroxid of sodium.

CHAPTER VI.

DISEASES OF THE DENTAL PULP.

THE pulp of a tooth, from the high degree of vitality with which it is endowed, is one of the most sensitive structures of the body, and, like other parts, is liable to become the seat of various morbid phenomena. Its susceptibility to morbid impressions is influenced by a variety of circumstances, such as temperament, habit of body, the state of the constitutional health, the condition of the hard structures of the tooth, etc. A cause, which under some circumstances would not be productive of the slighest disturbance, might under others give rise to acute inflammation, with all its painful and disagreeable

concomitants. Increased irritability (hyperesthesia) may exist independently of any organic change, either in the pulp, dentine, or enamel. Examples are often met with in females during gestation; but it arises more frequently as a consequence of caries than from any other cause connected with the teeth. Even before the disease has penetrated to the central chamber of the organ the pulp often assumes a most wonderful and marked increase of irritability, either from functional disturbance arising from decomposition of the dentine, impaired relationship between the two, or from being more exposed to the action of external deleterious agents. Impaired digestion, as well as a disordered state of other functions of the body, frequently produces the same effect.

The susceptibility of the pulp to impressions of heat and cold and of acids is always increased by heightened irritability. When this exists to any considerable degree the mere contact of these agents with the tooth is often productive of severe pain, which on their removal very soon subsides. The pulp, however, may remain in this condition for months, and even years, without becoming the seat of inflammatory action.

Preternatural sensibility of the dentine, whether in a sound or partially decomposed state, augments very appreciably the irritability of the pulp. The sensibility of dentine is sometimes so much increased that the mere contact of any hard substance with a part which has become exposed by the destruction of a portion of the enamel is often productive of severe pain. Impressions of heat and cold conveyed through the conducting medium of a metallic filling, or through a thin covering of dentine, as sometimes happens when a considerable portion of the tooth has been worn away, is a very frequent cause of heightened irritability of the pulp. With its susceptibility thus increased, the impressions produced by these agents are often a source of irritation and even of inflammation and suppuration, causing the death of the entire crown and inner walls of the root of the tooth. At other times the irritation is only followed by slight increase of vascular action and an effusion of plastic lymph over the affected part of the pulp, which is gradually converted into *osteo-dentine;* and thus a barrier is interposed between it and the irritating agents.

Hyperemia and Irritation.—The pulp of a tooth may become the seat of severe pain even when there is no inflammation. The slightest increase of vascular action, a condition known as *hyperemia,* when this organ is in a preternaturally irritable condition, is productive of more or less irritation. The pressure of even slightly distended vessels upon the nervous filaments distributed upon it, at such times, is sufficient to cause pain.

Hyperemia of the dental pulp may exist in any degree, according to the increased amount of blood which expands its vessels. The coronal portion of the pulp, what is generally known as its "bulb," exhibits the greatest distention under such conditions, and the pain resulting is often sharp and lancinating, and even paroxysmal in character. The pain from hyperemia is often referred to other organs, such as the ear, face, and in fact to any part of the distribution of the fifth pair of nerves. Hyperemia may result in diffuse inflammation of the pulp when the red blood-globules escape through the pulp-tissue, which generally occurs at the point where the distention is greatest. This condition is liable to occur in sound teeth as well as in carious ones, although the approach of caries to the pulp-chamber is perhaps, the most frequent cause of irritation of the pulp. Within certain limits hyperemia is a physiological condition, an impression induced by a temporary excitant, which soon passes away without injury to the parts involved. But when the cause is sufficient to bring about repeated attacks, the vessels of the pulp fail to contract, and remain distended with blood, and the affected organs become very susceptible to even slight thermal changes, and the hyperemia becomes pathological instead of physiological. The treatment for hyperemia or irritation of the dental pulp consists in the removal of the cause of irritation and the protection of the tooth from all thermal and other influences which may cause irritation, by disinfecting and filling the cavity. In the case of very sensitive teeth the use of non-conducting filling materials, such as gutta percha, or the oxyphosphate or oxychlorid of zinc preparations is indicated ; in cases of otherwise healthy and sound teeth they should be protected from thermal changes until the susceptibility to such influences has passed away. Dr. G. V. Black recommends for the latter case a closely-fitting gutta-percha cap as a protection.

Impressions of heat and cold are conveyed more readily to the pulp when the dentine is in a morbidly sensitive condition, and when this is the case they produce a more powerful effect.

The remedial indications of pain in a tooth arising simply from irritation of the pulp, consist in the removal of the primary and exciting causes. When produced by impressions of heat and cold conveyed to it through the conducting medium of a metallic filling and intervening super-sensitive dentine, if the severity and continuance of pain is such as to warrant the belief that it will give rise to inflammation, the filling should be removed and some non-conducting substance placed in the bottom of the cavity before replacing it. If this is done before inflammation actually takes place it will prevent subsequent irritation from these causes. It is worthy of remark, however, that the

pain thus produced is in proportion to the sensibility of the subjacent dentine. If this is destroyed previously to filling the tooth, irritation of the pulp will be as effectually prevented as by the interposition of a non-conducting substance. But in the application of agents for this purpose there is danger of destroying the vitality of the pulp. The employment of them, however, is resorted to more frequently to prevent pain during the removal of caries than to relieve any subsequent irritation from impressions of heat and cold. (See Hypersensitive Dentine.)

Although a frequent cause, yet a metallic filling is not the only medium through which impressions of heat and cold are conveyed to the dental pulp. When the dentine on the coronal extremity or side of a tooth becomes very thin from loss of substance occasioned by mechanical abrasion or erosion, by the use of a cutting instrument, or other cause, the pulp sometimes becomes painfully susceptible to the action of these agents. Loss of substance from any of these causes is also often attended by exalted sensibility of the exposed dentine; and when this is the case the contact of acids with it is productive of more or less pain. Nature, however, usually prevents the painful consequences that would naturally arise from continued abrasion of the coronal ends of the teeth, and the consequent exposure of their nervous pulp, by the gradual ossification of this organ; so that by the time it would become exposed it is converted into osteo-dentine. But this does not always take place in time to prevent irritation and pain.

When irritation of the pulp occurs in a tooth that has been so much cut away as to leave only a thin covering of dentine over the pulp, the best known means of preventing morbid sensibility is to keep the cut surface constantly clean by frequent friction with a brush and waxed floss silk, or with some other suitable substance. This operation should be repeated after each meal, and in the morning immediately after rising, and at night before going to bed. The application of nitrate of silver for sensitiveness arising from loss of substance or from exalted sensibility of exposed dentine, has proved successful. The nitrate in the solid form may be applied by enveloping a portion of the stick with wax, which will enable the operator to handle it with impunity. Or the end of a silver wire may be dipped in nitric acid and the application be thus made to the sensitive surface, taking care to protect the adjacent parts. Some are in the habit of applying salt as soon as the sensitive surface has been touched with the nitrate, to neutralize its effects. To prevent contact with the gum, when it is necessary to apply the nitrate to the necks of the teeth, a coating of collodion may be painted on them with a camel's-hair brush. But discoloration may

result from such an application. Chromic acid has also been used in these cases with success.

The careless use of the burr, and also of sand-paper discs, in the dental engine, may also induce irritation of the dental pulp on account of the heat generated by such agents.

When caries has extended to the central cavity, irritation is often produced by contact of partially decomposed portions of dentine or other foreign matter with the pulp. The proper remedial indication in such cases, it is scarcely necessary to say, consists in the removal of all matter from the teeth that can either act as a mechanical or chemical irritant. This done, the cavity in the crown of the tooth, supposing the pulp to be in a healthy condition, should be properly filled.

But when the irritation arises as a consequence of exalted irritability and increased vascular action of the pulp, dependent upon disease or altered function of some other part or parts of the body, the remedial indications are different. The treatment then should be addressed to the primary affection. Examples of this sort are of frequent occurrence. They are met with almost daily, particularly in females during gestation, in dyspeptic individuals, and in persons affected with gout and chronic rheumatism. They are also sometimes met with in individuals who have been exposed to miasmatic emanations of marshy districts, when the irritation assumes an intermittent form, occurring at stated intervals of twenty-four, forty-eight, or seventy-two hours, and continuing from one to three hours. Some of the worst forms of toothache are produced by one or other of these causes.

The local disturbance, when it occurs in females during pregnancy, may generally be removed by mild aperients, warm foot-bath, and anodynes at night on going to bed. When it depends upon other kinds of derangement of the uterine organs, treatment suited to the peculiar indications of the case should be instituted. When it occurs in a person affected with dyspepsia, rheumatism, or gout, the constitutional treatment required by the particular disease constitutes the proper remedy. When the irritation assumes an intermittent form, an emetic or cathartic, followed by quinine, will generally put a stop to the local disturbance, provided it has no connection with caries of the crown of the tooth.

INFLAMMATION OF THE PULP—PULPITIS.

The pulp of a tooth, when healthy, has a grayish-white appearance, and its capillaries are invisible to the naked eye, but when it becomes the seat of *acute* or *active* inflammation, they may be distinctly seen, as the organ then assumes a bright red color. Inflammation, having established itself, soon extends to every part of the pulp, and even to

the peridental membrane. When permitted to run its course uninterruptedly, it usually terminates in suppuration in from three to eight or ten days.

The unyielding nature of the walls of the cavity in which it is on all sides inclosed renders expansion of the pulp impossible, and as its capillaries become distended with blood, they press on the nervous filaments which are everywhere distributed upon it, causing at first constant gnawing pain, which afterward, as the distention of the vessels increases, becomes severe, deep-seated, throbbing, and sometimes almost insupportable.

Inflammation may attack the pulps of sound teeth as well as those affected with caries; but it occurs more frequently in the latter than in the former, and it is oftener met with before than after the pulp has become actually exposed. The severity of the pain, however, is determined by the condition of the tooth, the state of the general health, and the causes concerned in its production. The pulp, when in an irritable condition, is more liable to become the seat of acute inflammation than when in a perfectly healthy state, and the occurrence of suppuration is soon followed by alveolar abscess, unless an opening is made immediately through the crown, neck, or root of the tooth, for the escape of the matter.

The effusion of lymph, which takes place during the inflammatory stage, and which, under other circumstances, and when the inflammation is less severe, is made to play an important part in the reparation of the injury, compresses the pulp into still narrower limits as it accumulates in quantity, and thus becomes an additional source of irritation, adding fuel to the flame already lighted up.

Inflammation of the pulp may be caused by a blow on the tooth; by impressions of heat and cold conveyed to it through the enamel and dentine, or through a metallic filling; or by the pressure of a filling, or the direct contact of external irritating agents, such as disorganized portions of the tooth, particles of alimentary substances, acrid humors, etc. But, as we have stated in another place, *inflammation* of the dental pulp is not always a necessary consequence of impressions of heat and cold; pain may be produced by them when pulpitis does not exist; but in this case it usually subsides soon after the removal of the irritant. The exposure of the pulp by decay is a common cause of inflammation of the organ, also abrasion and the careless preparation of a cavity for the insertion of a filling, although in rare cases the pulp of a tooth may be exposed for months, and subjected several times a day to the actual contact of foreign bodies, without becoming the seat of acute inflammation. The irritation and increased vascular action thus occasioned are, no doubt, removed by the effusion of lymph to which they

give rise, and the pulp, after it has become exposed, having room to expand as its vessels become distended, does not suffer irritation from the pressure to which it would otherwise be subjected.

Where suppuration takes place, the pain very nearly ceases, but the tooth for a time remains sore to the touch, and its appearance is changed. It has no longer the peculiar animated translucency of a living tooth, but has assumed an opaque, muddy or brownish aspect. With the disorganization of the pulp, the entire crown and inner walls of the root lose their vitality; still, if the peridental membrane has not become seriously involved in disease, the vascular and nervous supply furnished to the cementum is often sufficient to prevent the tooth from exerting any injurious influence upon the surrounding and more highly vitalized parts. The cementum, being more analogous in structure to true osseous tissue than dentine, now plays an important part in the animal economy. It being more liberally supplied with vitality and with nutritive fluids, and not being sensibly affected by the death of the other parts of the organ, it keeps up the living relationship of the tooth with the peridental membrane, at least sufficiently to prevent it from acting perceptibly as a morbid irritant.

Inflammation of the pulp of a tooth, besides the local pain with which it is attended, often gives rise to a train of constitutional morbid phenomena, usually of a mild, but sometimes of an aggravated and even threatening character. Among these are *headache*, *constipation of the bowels*, *furred tongue*, *dryness of the skin*, *quick*, *full and hard pulse*, *earache*, *ophthalmia*, *disease of the maxillary sinus*, etc.

The amount of constitutional disturbance arising from inflammation of the pulp of a tooth depends on the state of the general health, and the nervous irritability of the system at the time. In the majority of cases it may occasion but little inconvenience, and disappear as soon as the inflammation ceases, but sometimes it assumes a very alarming character. A fatal case of tetanus, produced by inflammation of the pulp of a lower molar, occurred a number of years ago in Baltimore. The subject was a young lady about eighteen years of age. The system at the time, from great bodily fatigue and mental excitement, was in an exceedingly irritable condition, but in other respects, though constitutionally rather delicate, she was in the enjoyment of good health.

There is not an organ or tissue of the body in which acute inflammation is more intractable in its nature and rapid in its progress, than in the pulp of a tooth; and when we take into consideration its situation, and its physical and vital peculiarities, it is not to be wondered that it should, in so large a majority of the cases, termi-

nate in the disorganization of the part. Still, it may sometimes be arrested, and the remedial indications here, though they cannot be as readily and fully carried out, are the same as for inflammation in any other part of the body. The first and most important one consists in the removal of all local and exciting causes. For simple exposure of the pulp, without sloughing, the first step, after removal

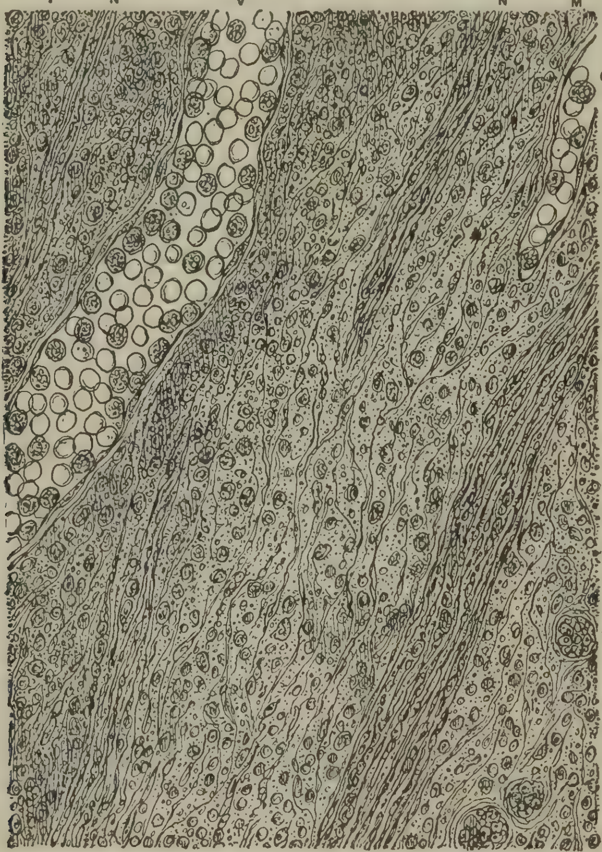


FIG. 124 REPRESENTS AN AREA OF PULP AFFECTED WITH ACUTE PULPITIS. (*After Bödecker.*)
I. Intensely-inflamed portion. M. Moderately-inflamed portion. S. Slightly-inflamed portion. N, N. Small bundles of medullated nerves, slightly inflamed. T. Nerve-bundle in transverse section. V. Vein, engorged with red and colorless blood-corpuscles. C. Capillary, engorged and widened. Magnified 500 diameters.

of all irritants from the carious cavity, is to attempt the reduction of inflammation and the prevention of the effusion of serum or lymph, by cleansing the exposed surface with tepid water, and, after careful drying, to bathe it with dilute tincture of aconite, when it may be

covered with a thin coating of a solution of gutta-percha in chloroform, or glycerin, or collodion carefully applied, and the tooth protected from irritation. Some prefer the use of a preparation composed of crystallized carbolic acid rendered fluid by a small quantity of chloroform. This preparatory treatment, if successful, is to be followed by the process of "capping the pulp," as described in another place. If it be the result of irritation produced by the pressure of a filling, the plug should be immediately removed, leeches applied to the gum of the affected tooth, and, if the patient be of a full habit, blood may be taken from the arm, and a brisk saline purgative prescribed. The removal of the filling, however, when the inflammation has previously made much progress, will not prevent suppuration, but it may keep it from extending to every part of the pulp. When an external opening is made for the escape of the matter, the moment suppuration takes place the remaining portion of the pulp will be relieved from the pressure which caused the irritation, and then the inflammatory action may cease. But if the matter remains in the central cavity of the tooth, the part of the pulp which has not suppurated will still be subjected to pressure, and the inflammation and suppuration will go on until the entire organ perishes. Nor will the disorganizing process stop here. The peridental membrane at the extremity of the root will soon become implicated, and in a short time alveolar abscess will form, thus terminating the acute stage of the disease.

There may be no indication of irritation or inflammation for several weeks, or even months, after a tooth has been filled; but at the expiration of this time the pulp, from increased irritability, caused perhaps by some change in the state of the patient's general health, may be attacked by inflammation. Although this very seldom happens, it does, nevertheless, sometimes occur. When there is reason to apprehend that it is about to take place—and it may be suspected if pain is felt in the tooth when anything hot or cold is taken into the mouth, or if it becomes the seat of gnawing or gradually increasing pain—the filling should be removed. If the pain now ceases, a thick layer of gutta-percha dissolved in chloroform, or Hill's stopping, or oxychlorid or oxyphosphate of zinc preparation, may be placed in the bottom of the cavity and the filling replaced; using the precaution, as before directed, to introduce the gold in such a way as to prevent the liability of depressing the floor of the cavity; or a temporary filling of some plastic, non-irritating substance, such as Hill's stopping or chloropercha, may be inserted and permitted to remain for some time, when a more durable filling may be introduced. But if the pain and inflammation continue unabated, and the application of such escharotics as

carbolic acid, chlorid of zinc, nitrate of silver, and chromic acid, fails to reduce the congestion, it may be necessary to expose the pulp and destroy its vitality. When this is done it is usually with the view of securing the retention and preservation of the tooth by filling the pulp-cavity and root.

It is not advisable to attempt to preserve the vitality of the pulp when it is affected with the diffuse form of pulpitis. The pulp in such cases should be completely extirpated and the pulp-canal be thoroughly disinfected and filled. A purulent condition of the pulp is evident when pus oozes from the pulp-chamber as soon as it is opened, and relief from pain ensues almost instantly. The treatment of such cases consists in removing the putrescent pulp and disinfecting and filling the pulp-canal.

Chronic inflammation of the dental pulp often occurs where the pulp-chamber of a tooth has become gradually exposed by caries of the dentine; and when this happens the action of the fluids of the mouth, and of other foreign substances which obtain access to the cavity, as well as of the decomposed portions of the tooth-substance, causes an increase of vascular action in the exposed part, followed very often by a slight discharge; but the morbid action thus induced is comparatively seldom accompanied by pain. The pulp may remain thus partially exposed for months, and even years, without causing any other inconvenience than a momentary twinge of pain when some hard substance is accidentally introduced into the cavity of the tooth, which subsides immediately after its removal. Sooner or later, however, the pain thus excited will become more permanent, continuing each time it occurs from five to ten minutes to one or more hours after the cause of the irritation has been removed. If a tooth be filled under such circumstances, the pressure of the fluid upon the pulp, which is poured out from its exposed surface beneath the filling, will give rise to a more general and active form of inflammatory action. Pain, too, is often experienced before actual exposure of the pulp occurs.

The liability of the tooth to ache increases as the pulp becomes more and more exposed by the gradual decomposition of the dentine; and the inflammation may ultimately assume a more active form, when the pain becomes very acute, owing to the consequent effusion into tissue surrounded by unyielding walls, or the pulp may become the seat of fungous growth, or it may be absorbed or destroyed by ulceration, or by gangrene and mortification. Cases sometimes occur in which the disease is attended with severe darting pains, often occurring several times in the space of two or three minutes, succeeded by intervals of perfect ease for many hours. At other times it is attended by dull, aching pains, aggravated by taking sweet or acid substances into the

mouth. In cases of this sort the application of heating or stimulating substances to the exposed surface of the pulp will usually procure relief. Permanent exemption from pain, however, is not always obtained, and sooner or later it may become necessary either to destroy the pulp or to extract the tooth. In some cases, however, where the pulp becomes exposed by the action of caries, no pain is experienced except by contact of foreign substances with the exposed surface.

The body of the pulp, when the organ becomes exposed from a decayed opening in the grinding surface of a molar, is sometimes absorbed, while its prolongations in the roots often remain unchanged for two or more years.

Long exposure of the pulp is usually attended with *ulceration*—a disorganizing process, which often causes the destruction of a large portion of the part occupying the central chamber of the crown of the tooth, making in it numerous little excavations. The ulcerated surface usually presents a yellowish appearance, that of an irritable ulcer, with the exudation of a serous or sanguino-serous fluid, a condition, however, which must not be confounded with a state of suppuration. The exuded fluid is very offensive, as it rapidly decomposes, and its reaction is alkaline; when the disorganizing process is arrested before it has effected the destruction of any very large portion of the pulp, the remaining portion usually becomes covered with healthy granulations.

When the inflammation occurs in cachectic individuals it often assumes an acute form, and sometimes terminates in gangrene and mortification. The loss of vitality may be confined to the body of the pulp, or it may extend to every part of the organ. In the former case the pain continues, but in the latter it ceases as soon as mortification takes place. When this happens, the entire pulp, which has now a dark-brown or black color, may be removed. But this is not a very common termination.

The symptoms of chronic as well as acute inflammation are always modified by the state of the general health, habit of body, and the temperament of the individual. The pain attending the former, however, is periodical, occurring at irregular and uncertain intervals, and constitutes that variety of toothache so often relieved by local applications; whereas, in the latter, it is constant.

In chronic inflammation, which implies a state of ulceration, the pulp is either actually exposed or only covered by decomposed or partially decomposed dentine, and the diseased surface rarely embraces a larger circumference than that described by the bottom of the decayed cavity. The inflammation, therefore, is local as well as chronic, but, nevertheless, it is often of so persistent a character as to render

its removal exceedingly difficult. The dentist, however, is not so much restricted in the application of remedies as in the treatment of acute inflammation, and to the action of which it yields more readily. But notwithstanding all this, he will necessarily encounter difficulties in his efforts to subdue it. A greater length of time is sometimes required than the patient is willing to give; and the opening through the crown to the central cavity is frequently too small, previously to the removal of the partially decomposed dentine, to admit of the direct application of the necessary remedial agent to the inflamed surface of the pulp. Again, it often happens that the situation of the tooth and cavity are such as to prevent a complete view of the diseased part. It is important that the operator should get such a view to enable him to determine whether the inflamed surface is ulcerated, or pours out a serous fluid; or whether the morbid condition is simply one of irritation, produced by the presence of acrid matter, or of partially or wholly decomposed dentine. Unless his diagnosis is correct, his prescription will be as likely to do harm as good; but, having ascertained the exact character of the disease, he may often be able to institute treatment that will result in the restoration of the pulp and the preservation of the tooth.

It is important, too, to understand the part which nature plays in the curative process; for cure here, as in other parts of the body, is effected by that internal force which, as Chomel says, "presides over all the phenomena of life, contends unremittingly with physical and chemical laws, receives the impressions of deleterious agents, reacts against them, and effects the resolution of disease." This vital force is sometimes exercised in the cure of disease in the pulp of a tooth, but more frequently in its prevention; as is shown by the gradual ossification of the organ in those cases where it would otherwise become exposed by mechanical or spontaneous abrasion of the solid structures which enclose it; and occasionally by the formation of secondary dentine upon the surface of the original or primary dentine at a point toward which the caries is advancing. Nature, no doubt, would always provide in this way against the exposure of the pulp, if the occurrence were always long enough preceded by sufficient irritation or increase of vascular action in it to call her energies into operation. But the formation of osteo-dentine, which constitutes the protective wall of defense, is a tardy process, and, as a general rule, proceeds more slowly than the caries in the tooth, which causes the exposure of the pulp. Besides, it often happens that the approach of the caries is not announced by the slightest irritation, a condition necessary to the new formation of dentine, until it reaches the central cavity. At other times the approach of the disease gives rise to too much irritation,

a condition equally unfavorable to the dentinification of the pulp. Thus, no protective covering being formed, it soon becomes exposed, when it is subjected to the action of such irritating agents as may chance to be brought into contact with it. Hence its liability to become the seat of chronic inflammation as well as other forms of diseased action.

If the disease is attended with pain, the removal of this must first claim attention, and should be effected with as little delay as possible; otherwise the morbid action may extend to every part of the pulp and peridental membrane and assume a more active and unmanageable form. If the pain is the result of irritation produced by the direct action of mechanical or chemical agents, the cavity in the tooth should at once be carefully freed from all extraneous substances and decomposed portions of dentine. This done, a dossil of raw cotton or lint—saturated with spirits of camphor, laudanum, sulphuric ether, chloroform, creasote, or some one of the essential oils—may be applied. The following anodyne application has been employed with advantage to relieve the pain arising from congestion of the pulp: Cotton saturated with a solution composed of alcohol, 1 ounce; chloroform, 2 ounces; ether, 3/4 ounce; gum camphor, 1/2 ounce; tincture of opium, 1/2 ounce; and oil of cloves, 1 dram. When the pain is relieved another application, consisting of carbolic acid and oil of cloves, is made and permitted to remain for some fifteen minutes. A paste composed of iodoform and glycerin is also employed after the active symptoms of congestion have subsided.

For the treatment of wounded and irritated pulps the tincture of calendula proves a very useful remedy. Such agents as glycerole of thymol, carvacrol, oil of eucalyptus, tannic acid, lead water, morphine, creasote, chloral, and tincture of aconite have also been found serviceable in the treatment of inflamed conditions of the pulp.

When the irritation is produced by acidulated buccal fluids, the application of carbonate of soda, or some other alkali—tepid water containing sufficient carbonate of soda to make it slightly alkaline—will often give immediate temporary relief; but as the condition of the secretions of the mouth, especially the salivary, is usually acid, owing to gastric derangement, the correction of this constitutes the first and most important remedial indication. When any application is made to the pulp for the purpose of removing irritation and pain, its full effect will not be obtained unless the fluids of the mouth are excluded from the cavity of the tooth; this may be done by closing the orifice with softened wax, or cotton saturated with the sandarach solution, using the precaution not to force it so far as to press the application previously made upon the exposed pulp.

Suppuration of the Pulp.—Independent of the condition known as alveolar abscess, the pulp of a tooth is liable to suppuration when exposed for a considerable time, by the formation of either an abscess within its substance, or, more frequently, by a superficial suppression on its surface.

In such cases, layer after layer of the substance of the organ is destroyed at the point of exposure, and inflammatory elements or products take their places. The layer of odontoblasts is disorganized as a result of superficial inflammation, and becomes a mass of sanious pus filled with micro-organisms. Deep pockets are formed in the substance of the pulp by the suppurative process, and a section of the organ is progressively destroyed from the exposed surface in the direction of the root. This progressive suppuration and destruction may continue until a small portion only remains in the apical portion of the root-canal, or the entire organ is destroyed. Many histologists are disposed to question the theory that the dental pulp ever recovers after suppuration is once established in it, while some contend that cicatrization and ability to perform its functions are possible after such attacks.

Suppuration of the pulp generally commences in the form of small collections of pus within the layer of odontoblasts which may retain their distinct forms for some time, when they may coalesce. Deeper in the structure of the pulp a large abscess may undermine the layer of odontoblasts, and if the pus generated under such circumstances is greater in quantity than the cavity for its retention, compression and strangulation of the pulp result, causing the destruction of the organ. The pain accompanying abscess of the pulp generally commences with a slight gnawing sensation, which persistently increases in severity until it becomes very excruciating. When decomposition of the entire pulp occurs, gas is generated, which, by its pressure, gives rise to severe pain, and the trouble is only relieved by a vent being made for the escape of the gas and secretion. It is seldom, however, that gas is formed within the living pulp, although there are cases sometimes met with where gas is generated in a closed pulp-cavity during the progress of the suppuration in the pulp. A small amount of pus in a pulp-chamber may undergo absorption, for even fatty degeneration, but such cases are rare.

The causes of putrescent pulps may be enumerated as follows: Mechanical violence, such as blows; the careless regulating of teeth; the rapid separation of teeth by wedges, screws, etc., or separation by any method when the condition of the system contraindicates such an operation; thermal influence through a metallic filling, and especially

in the case of young teeth ; exposure of the pulp to irritating agents. A dead pulp may remain quiet for months, or even years, and if not exposed by caries, even for many years, but the action of the atmosphere may in a very short time cause inflammation of the peridental membrane ; hence it is often a question whether teeth in which dead pulps are quiescent should be interfered with. But as all such teeth are liable to cause periodontitis and alveolar abscess, the treatment of such cases, where no exposure exists, is to make an opening with a drill into the pulp-chamber, the entrance of the instrument being easily recognized by its sudden opening into such a space.

When this is effected, an antiseptic agent, such as oil of eucalyptus, iodoform in the form of an ethereal saturated solution, or permanganate of potash, etc., etc., should be introduced into the pulp-cavity, taking care to leave a vent through the temporary filling which is to confine the antiseptic agent. The remains of the devitalized pulp should be removed at a second sitting by means of a barbed broach, and the pulp-canal thoroughly disinfected. Such treatment should be continued until all odor of decomposition has disappeared, and the cavity will permit of being closed tightly without trouble ensuing. The antiseptic agent must be thoroughly applied, so that it may pass into every part of the pulp-cavity and the dentinal tubes. It should be remembered that the product of decomposition, which is principally sulphuretted hydrogen exhibited in the form of gas, is not only rapidly developed, but exerts great pressure in the apical space ; hence the roots of a tooth thus affected should not be filled until there is every reason for believing that the decomposition has been overcome. It may be necessary in these cases to continue the disinfectant and antiseptic treatment for several weeks before filling the pulp-cavity, although immediate root-filling, even in such cases, has its advocates.

Atrophy, or Degeneration of Structure.—This condition may result from a low degree of inflammation of the pulp when long continued, which has the effect of so reducing its volume that it presents a shriveled appearance, and to which the term "mummified" has been applied.

The pulp-cavity in such cases is entirely free from any products of decomposition, and the tooth retains its natural color. This affection appears to be more common to teeth of a dense structure, and has been ascribed by writers on this subject to a gradual obliteration of the tubuli by a deposit of secondary dentine, which interferes with nutrition to such a degree as to produce attenuation. The original cells of the tissue disappear and are changed into fine fibres, and areolæ are developed in the matrix, and the sensibility of the pulp is either greatly diminished, appearing like a thin, flattened thread, or

altogether destroyed, the latter being the condition of completely mummified pulps. Wedl attributes this atrophy to a withering of the reticulated connective-tissue cells, together with the peripheral blood-vessels and nerves. Dental pulps in such a condition may never become a source of irritation, if atmospheric germs are not admitted by the opening of the root-canals, and the only treatment required is the removal of the remains of the attenuated organ and the disinfection and filling of the root-canals.

Disorganization, or Gangrene.—The disorganization of the pulp of a tooth is generally the result of acute pulpitis where micro-organisms gain access to the inflamed pulp, which is transformed into a dark-brown or grayish fetid mass, the odor being due to the generation of putrefactive gases. The accumulation of these gases in the pulp-chamber, it is claimed, has caused the bursting of the crown of the teeth with a loud sound. Dry gangrene of the pulp is a condition due to the obstruction of the afferent artery, as by an embolus or blood-clot. The pulp when in this condition presents the appearance of a grayish-white dry substance, without odor. In all of the cases which have attracted the attention of the author, the disorganization has been carried on so insidiously that neither the presence of disease nor structural alteration was suspected until the teeth assumed a dull brownish or bluish-brown appearance. The death of the pulp had not been preceded in any of these cases by the slightest indication of inflammatory action. It had apparently resulted from want of sufficient vital energy to sustain the nutritive function.

The alveolar cavities of the affected teeth in these cases were, seemingly, in a healthy condition—a circumstance which, when we take into consideration that the parts of the extremity of the roots were exposed to the action of the disorganized remains of the dental pulps, may appear somewhat strange. But this may have been owing, partly, to diminished excitability in the peridental membrane, and partly to the smallness of the quantity, and the innocuous character of the matter contained in the central cavities of the teeth. The gums of that portion of the alveolar border occupied by the affected teeth had a pale, grayish-purple appearance, but exhibited no indications of actual disease. They were as thin and their margins as distinctly festooned here as in any other part of the mouth. In some instances, the teeth had been in this condition for seven or eight years.

The remedial indications in cases of this kind are the removal of the pulp and the disinfection and filling of the root canals.

Fatty Degeneration.—This affection of the pulp, according to Wedl, is of frequent occurrence. The fatty pulp presents a cloudy appear-

ance, and under the microscope appears to be full of fat-granules in all of its constituent elements.

This condition is also observed in deciduous teeth when their roots are undergoing the process of absorption.

Fungous Growth.—The pulp of a tooth, when exposed by decay of the crown, sometimes becomes the seat of a fungous growth, in the form of a small vascular tumor, the formation of which is caused by constant irritation. These morbid growths sometimes attain the size of a large pea, completely filling the cavity made in the crown of the tooth by caries; at other times they do not exceed that of a small elderberry. The former have little sensibility, and bleed freely from the slightest injury; the latter are less vascular, but are nearly as sensitive as the pulp in a healthy state.

It often happens that a fungous growth of the gum or peridental membrane, finding its way through an opening in the side of the neck or root of a decayed tooth, appears in the central cavity, and is sometimes mistaken for a morbid growth of the pulp. But the character of a fungous growth or polypus of the pulp can be readily determined by its attachment to the portion of the organ occupying the pulp-chamber by a constricted neck. Such fungous growths have a dark-red color and a fleshy or spongy consistence. Such fungous growths are more common to the pulps of the inferior molar teeth when caries has hollowed out the crowns to a considerable degree. Such tumors usually grow very fast, and sometimes attain the size of a hickory nut. They are exceedingly vascular, bleeding profusely when wounded, and are soon reproduced after removal. The author has met with tumors of this kind which had originated in the peridental membrane of the extremity of the alveolar cavity.

Where there is a tendency to fungous growth of the pulp, the application of an escharotic has proved serviceable. Of these agents chromic acid appears to be very effective.

Another method is to apply carbolic acid freely to the fungous growth, to obtund its sensitiveness, excise it, and then make an application of nitric acid on a disc of card-board. A method of treating such a fungous growth is described by Dr. Maercklein as follows: After carefully removing all foreign substances and carefully drying the cavity, apply the tincture of iodin with a pledget of absorbent cotton or bibulous paper until the entire growth is covered with the iodin; after which seal the cavity in the usual manner. This should be repeated every twenty-four hours until it has been completely destroyed. If the fungous growth should fill the entire cavity, take small pledgets of the paper or cotton saturated with the iodin and

place them between the fungoid and the walls of the cavity until as much pressure has been made as is consistent with the comfort of the patient, but in no case giving pain. This dressing is repeated daily until sufficient room has been obtained to proceed as in the first case.

FIG. 125.—PULP WITH PULP STONES. C. C. Calcareous globules. L. Lymph vessel. N. N. Bundles of medullated nerves magnified 10 diameters.

It frequently happens, however, that teeth with pulps in this condition are too far gone to justify their retention.

Calcareous Concretions.—Calcareous depositions in the shape of nodules and irregular needles or spiculæ are often found in the pulp, and

are ascribed to a calcification of the cells or to a direct impregnation of the organic substance with lime salts. Fig. 125 (after Bödecker) represents a pulp with the so-called pulp-stones imbedded in its substance.

The age of the person does not appear to influence the formation of these calcic deposits, as the teeth of both young and old are subject to calcification. Calcified pulps contain more fibrous connective tissue than myxomatous tissue, and Bödecker states that "invariably around the calcified masses a dense layer of fibrous connective tissue has formed, ensheathing the calcified masses." "Where these masses" (or pulp-stones) "have fallen out an empty fibrous sac is left behind, in which there are neither endothelia, so characteristic of blood-vessels, nor oblong nuclei, which we see in the external perineurium of the bundles of medullated nerve-fibres. The presence of this envelope may convey the idea (especially if the calcified masses are elongated and appear like small, lobulated sausages) that an obliteration has first occurred in the blood vessels by a process which in other vascular systems, mainly that of the lungs, is known as 'fatty embolism.'" Dr. Bödecker also ascribes the primary cause of calcification in an unerupted wisdom tooth to be embolism of micrococci of an unknown nature in the arteries and capillaries which did not cause pulpitis. Others ascribe the deposit of lime-salts to the plasma of the blood laden with such salts accumulating in the capillaries of the pulp and unable to escape. Fig. 126 represents calcification in the pulp of a first lower molar of a healthy young man eighteen years of age.

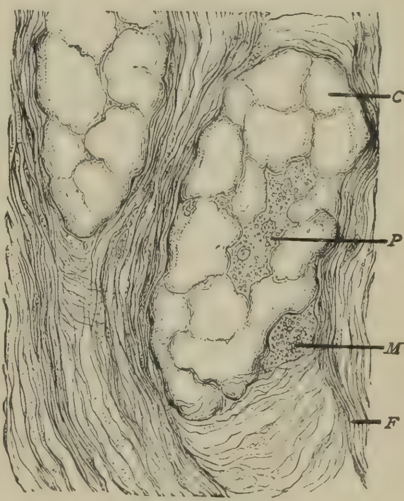


FIG. 126.—CALCIFICATION.
C. Calcified masses of irregular lumps, probably former medullary corpuscles. M. Medullary corpuscles unchanged. P. Central plastid, free from infiltration. F. Capsule of fibrous connective tissue. Magnified 300 diameters.

Ossification.—Allusion has been made several times, in the course of this work, to the ossification of the dental pulp as a means employed by nature to prevent the exposure of this most delicate and exquisitely sensitive structure. But examples of it are occasionally met with in teeth which have suffered no loss of substance, either

from mechanical abrasion or from the decay of the dentine. The occurrence, whatever may be the circumstances under which it takes place, is evidently the result of the operation of an established law of the economy, dependent upon moderate irritation and a slight increase of vascular action; ossification having commenced, it usually goes on until every part of the pulp is converted into a substance analogous to cementum. We infer, then, that when the pulp of a tooth becomes the seat of a sufficient amount of irritation, ossification must follow as a necessary consequence; but if the irritation be succeeded by active inflammation, a different result may be expected.

The irritation necessary for the ossification of the pulp of a tooth sometimes arises from constitutional causes; but in the majority of cases it results from the action of local irritants, and most frequently from impressions of heat and cold, communicated through the medium of a metallic filling or a thin layer of dentine.

During the ossification, a sensation is occasionally experienced in the tooth somewhat similar, though altogether less in degree, to that which attends the knitting of the fractured extremities of a broken bone. A numb, vibratory pain, barely perceptible, is first felt passing through the tooth several times a day, but only lasting a second or two at a time. It is often scarcely sufficient to occasion any annoyance, or to attract anything more than momentary attention.

As the ossified deposit increases in size, pain of a neuralgic character may ensue, and similar to the sensation which results from the knitting together of the fractured extremities of a bone, but not constantly severe. At times, however, the pain becomes sharp and darting, affecting the side of the face and head. The treatment consists in the application of an anodyne, such as lead water, about the affected root and the opening of the pulp-chamber, in order to remove the affected pulp, which should be completely extirpated and the root-canals filled.

With the ossification of the pulp, the crown and inner walls of the root lose their vitality, but the appearance of the tooth is not, as in the case of necrosis arising from the disorganization of the pulp, materially affected. The central cavity being filled with semi-translucent osteo-dentine, the crown retains its natural color. The discoloration and opacity attending necrosis produced by other causes result partly from the presence of putrid matter in the pulp-cavity, and partly from its absorption by the surrounding dentinal wall.

Odontalgia.—Pain in a tooth, toothache, or *odontalgia*,* as it is

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* So much has been said upon this subject in the consideration of the different forms of inflammation of the pulp in the preceding pages, that but little remains to be noticed.

technically termed, is a symptom of some functional or structural disturbance, either of the organ in which the pain is seated, or of some other part or parts of the body, but more frequently of the former than of the latter. So variable is the character of the sensation, that any description would fail to convey to one who has never experienced it a correct idea of its nature. The pain sometimes amounts only to slight uneasiness; at other times the agony is almost insupportable. It may be dull, deep-seated, boring, throbbing, or lancinating. It may be slight at first, gradually increasing in severity until it amounts to the most excruciating torture, or it may come on without any premonition whatever. It may be confined to a single tooth, or it may affect several at the same time. It may commence in one tooth and pass from thence to another, and continue until every one in turn has been attacked. It may continue for hours and days with scarcely any cessation; or it may be intermittent, the paroxysms recurring at stated or irregular intervals, and each lasting from thirty minutes to one, two, or more hours.

The causes of odontalgia are almost as numerous as are the varieties of character which it exhibits. Irritation and inflammation of the pulp, and inflammation of the investing membrane, are among the most frequent; but it is sometimes referable to a morbid condition of the nerve or nerves going to a single tooth, or of the trunk from which several teeth are supplied; also to derangement of the digestive organs, to increased nervous susceptibility of the uterus resulting from pregnancy, amenorrhea, etc., and to certain diatheses of the general system.

Inflammation of the peridental membrane and pulp may be produced by a blow upon a tooth, or by powerful impressions of heat and cold communicated through the enamel and dentine, or through a metallic filling; but it is more frequently occasioned by pressure, or by the direct contact of irritating agents, such as carious portions of the tooth, particles of food, acrid humors, and other irritating external substances. But inflammation is not always a necessary consequence of such impressions. Pain may be produced by them when inflammation does not exist; in this case it usually subsides soon after the removal of the irritant. Indeed, the pulp of a tooth may be exposed for months, and subjected several times every day to the contact of foreign substances, without becoming the seat of inflammatory action; and in the absence of this, the pain, though coming on with the suddenness of an electric flash, and often of the most excruciating kind, is seldom of long duration.

But when inflammation exists, the pain, which at first amounts only to a slight gnawing sensation, is more constant; after a while it

assumes a throbbing character, and if not promptly arrested it increases in severity and continues until suppuration of the lining membrane and pulp takes place. So long as it is confined to the parts within the pulp-cavity the pain is not increased by pressure on the tooth, nor is the tooth started from the socket, as in periodontitis. The locality of the inflammation may also be distinguished by the fact that cold water or ice applied to the tooth generally gives relief. But the inflammation rarely confines itself long to the interior of the tooth ; it usually soon extends to the peridental membrane of the root and its cavity, when a somewhat different train of phenomena are developed. Suppuration, however, having taken place, an abscess soon forms at the extremity of the root.

The severity of the pain attending *pulpitis* is doubtless owing to the fact that this exceedingly sensitive structure, as its vessels become injected, is prevented from expanding by the unyielding nature of the walls of the cavity in which it is situated. Its capillaries being thus distended, must, as a necessary consequence, press upon the nerves which are everywhere distributed through it, and the excruciating painful, throbbing sensation, by which this variety of odontalgia is characterized, is produced by the pulsation of these vessels. Hence, increased action of the heart and arteries, from whatever cause produced, augments the pain ; it is also more severe at night, while the body is in a recumbent posture, than during the day, because this position gives an increased fullness to the arteries of the head. The phenomena attending the inflammation, however, are influenced very much by the condition of the tooth and the habit of body of the patient.

When the inflammation is acute it extends to every part of the pulp and lining membrane. It also occurs more frequently before than after these tissues have become exposed, and generally terminates in suppuration. Chronic inflammation usually arises from partial exposure of the pulp, and may exist for months without being attended with pain ; but the pulp, when thus affected, is more susceptible to injury by heat or cold and by irritating substances ; and the liability of the tooth to ache, especially at night, is greatly increased.

Odontalgia, caused by acute inflammation of the investing membrane, is characterized by pain, at first dull, afterward acute and throbbing, soreness and elongation of the tooth, redness and tumefaction of the gums, and sometimes by swelling of the cheek ; indicating the formation of alveolar abscess. In this variety of odontalgia the tooth is often so much raised in its socket as to interfere more or less with mastication.

The pain attending the foregoing pathological conditions, when

severe and protracted, is often accompanied by constipation, headache, dryness of the skin, flushed cheeks, fullness and increased rapidity of pulse, and other constitutional symptoms.

The nervous susceptibility of the teeth is sometimes so much increased by organic and even functional disturbances of other and often remote parts, that the mere contact of the minute nerves of the pulp and the lining membrane against the wall of dentine which encases them is attended with severe pain. This variety of odontalgia is termed *sympathetic*, and is supposed to be the result of the transfer of nervous irritation, or, more properly, of *exalted sensibility* of the dental nerves, arising from a morbid condition or functional disturbance of some other part. If this hypothesis be true, it is probable that with this heightened nervous excitability there is a slight increase of vascular action in the pulp, with a corresponding increase of size in its capillaries; in consequence of which, it is fair to presume the nervous filaments supplying these tissues would be apt to respond painfully to the undue pressure. Though pain arising from this cause may have its seat in sound as well as in decayed teeth, it occurs more frequently in the latter than the former, owing to the fact that any structural alteration in the dentine adds to their already increased nervous excitability.

Persons of highly excitable nervous temperaments, pregnant females, and individuals laboring under derangement of the digestive organs, are particularly subject to this variety of odontalgia. Odontalgia arising from pathological conditions or functional disturbances of other parts assumes a great variety of forms. The pain may be continued, but more frequently it is periodical; it may be confined to a single tooth, or it may attack half a dozen or more at the same time. It sometimes also alternates with the paroxysms of rheumatism or gout, the pain in such cases assuming the specific character of these diseases.

In what is termed neuralgic odontalgia, "the pain," says Dr. Wood, "is usually of the acute character; sometimes mild in the beginning, gradually increasing in intensity, and as gradually declining, but usually very irregular; at one time moderate, at another severe, and occasionally darting with excruciating violence through the dental arches. Not unfrequently it assumes a regular intermittent form. Instead of pain, strictly speaking, the sensation is sometimes of that kind which is indicated when we say that the teeth are on edge, and is apt to be excited by certain harsh sounds, such as that produced in the filing of a saw, or by mental inquietude, and by the contact of acids or other irritant substances. Neuralgic toothache sometimes persists, with intervals of exemption, for a

great length of time. The diagnosis is occasionally difficult. When, however, it occurs in sound teeth, is paroxysmal in its character, is attended with little or no swelling of the external parts, occupies a considerable portion of the jaw, and especially when it alternates or is associated with pain of the same character in other parts of the face, there can be little doubt as to its real nature." This variety of sympathetic toothache is perhaps induced by caries, or by the manner in which the teeth are arranged in the alveolar arch, or by some peculiar susceptibility of the parts; as is shown by the fact that the pain usually ceases on the removal of all such causes of irritation.

But while, on the one hand, pain in the teeth may be caused by a morbid condition of other organs, these organs, on the other hand, frequently sympathize with the diseased condition of the teeth, and become, to quote the language of Mr. Bell, "the apparent seat of pain. I have seen this occur not only in the face, over the scalp, in the ear, and underneath the lower jaw, but down the neck, over the shoulder, and along the whole length of the arm." Cases of this sort are frequently met with.

Mr. Fox gives a striking example in a person from whom he extracted a tooth, which afforded little or no relief; in consequence of which his patient applied to him only two days afterward and requested the removal of several adjoining teeth, which were perfectly sound. This he objected to, and, suspecting the real nature of the disease, he immediately took him to Sir Astley Cooper, who, by dividing the affected nerve, produced a radical cure in a few days. The author is acquainted with a gentleman similarly affected. He has had all his teeth on the right side of both jaws extracted without obtaining any relief.

There is still another cause of odontalgia which we should not omit to mention—hypercementosis; but from the obscurity of the diagnosis, the existence of the affection can seldom be determined with positive certainty, except by the removal of the tooth. In the early stage of hypercementosis, when the trouble is thought to be in a tooth, the only method of relief is to open the pulp-chamber, devitalize and remove the pulp, and fill the root-canals.

Finally, some teeth, from peculiar constitutional idiosyncrasy, are more liable to odontalgia than others. It sometimes happens that every tooth in the mouth is destroyed by caries without being affected with pain, while at other times teeth apparently sound become the seat of the most agonizing torture.

The first thing to be attended to in the treatment of odontalgia is the removal of the causes which have given rise to it; this can only

be done by carrying out the curative and remedial indications of the morbid conditions and functional disturbances with which it is connected. While these continue, it will be impossible to obtain permanent relief. The sensibility of the nerves supplying a tooth may often be obtunded and the pain palliated by the application of stimulating and anodyne agents to the exposed pulp, but the relief thus procured is seldom of long duration. When their effects subside, the pain usually returns with increased severity. When the pain arises from chronic inflammation and irritation, produced by external agents on an exposed portion of the lining membrane, such applications may often be employed with great advantage; and among those which have been used for this purpose are creasote, the oil of cloves, cinnamon, laudanum, spirits of camphor, tannin, ether, chloroform, etc. But of all the remedies prescribed by the author he has found none more useful in allaying the pain than the following:—

℞. Sulphuric ether, ... ℥j.
Powdered camphor, . . ʒij.
Powdered alum, ... ʒij.
Sulphate of morphine, . gr. ij.

℞. Sulphuric ether, ... ℥j.
Creasote, ... ʒss.
Ext. of nutgalls, ... ʒj.
Powdered camph., . . . ʒss.

The alum should be very finely powdered, and all the ingredients well mixed before use.

℞. Chloroform,
Tinct. opii, . . āā . . . ʒij.
Tinct. benzoin, ... ʒviij. M.

℞. Chloral,
Camphor, . . . āā . . . ʒj.
Morphine, ... gr. ij.
Oil of peppermint, . . . ʒij. M.

After removing all foreign matter and carefully drying the cavity of the tooth, a small bit of cotton or lint dipped in either of the above mixtures may be applied, and renewed several times a day, if necessary. The relief obtained is, in the majority of cases, almost instantaneous; but as the effect is only temporary, the pain is apt to recur. The author has sometimes used a solution of gutta-percha in chloroform (chloro-percha). The application of a drop or two of this to the exposed pulp is usually followed by the immediate cessation of pain, and as the chloroform evaporates, a thin layer of gutta-percha remains, and serves for a time as a sort of protection to the pulp.

It often becomes necessary to have recourse to the destruction of the pulp, in order to preserve the tooth and restore its usefulness. This may be effected either by immediate extirpation with a small, sharp-pointed elastic stilet or probe, by the actual cautery, arsenious acid, carbolic acid, cobalt, or chlorid of zinc. Immediate extirpation, or the application of devitalizing agents, are the means usually employed for the purpose.

Pain in a tooth arising from acute inflammation of the pulp and lining membrane can only be relieved by the extraction of the tooth, the destruction of the pulp, or by subduing the inflammatory action; the last can seldom be done except by the most energetic treatment in the very beginning, in cases where the decay has not penetrated to the pulp cavity. The propriety or impropriety of extraction will be determined by the amount of pain, the degree of the inflammation, the condition of the parts with which the tooth is immediately connected, the effect of local disturbance upon the general system, the situation and importance of the tooth, and the extent of structural alteration which has taken place in the crown. If the retention of the tooth, on account of its location, or the loss of several other teeth, is of great importance to the patient, and the circumstances of the case justify a well-grounded belief that it can be preserved and rendered useful without acting as a morbid irritant, extraction should be avoided. In this case, supposing the inflammation to have proceeded too far to be arrested, the pulp may be destroyed and the tooth treated in the manner described in another chapter.

When the inflammation is produced by other causes than exposure of the pulp and the contact of external irritants, it may perhaps be successfully combated. The treatment is similar to that for local inflammation in other parts of the body; the administration of saline cathartics, the application of leeches to the gum of the affected tooth, abstinence from animal food and stimulating drinks. If the pulse is full and hard, blood may be taken from the arm with advantage. Diaphoretics are often beneficial, such as Dover's Powder or Spirit of Mindererus. Bromid of potassium, in doses of gr. v to gr. xl, with a mustard plaster to the back of the neck and a hot foot-bath, together with the local treatment for pulpitis, before described, will often be found efficacious. Should these means fail to arrest the inflammation, and suppuration take place, the formation of alveolar abscess may be prevented by promptly perforating the crown of the tooth for the escape of the matter; but such cases usually terminate in periodontitis, which perhaps arises as frequently from this as from any other cause.

As the treatment of periodontitis or inflammation of the investing membrane is described in another chapter, it is unnecessary to repeat it.

Odontalgia assuming a rheumatic or gouty character, calls for a somewhat different plan of treatment. In addition to the local means already described, it may be necessary to adopt the constitutional treatment applicable to rheumatism and gout. When the pain arises from increased vascular action and nervous irritation of the pulp, occasioned by a disordered condition of the digestive organs, and assumes an intermittent form, an emetic or cathartic, followed by the

use of quinin, will generally afford relief, provided caries has not penetrated to the pulp cavity. If dependent on general nervous irritability of the system, tonics, exercise, change of air, or such other constitutional measures as the peculiarities of the case may indicate, should be recommended.

The extraction of the tooth is the only remedy that can be relied upon for relief of pain arising from hypercementosis when the formation of cementum has attained considerable size. The internal use of iodid of potassium in the early stage of the growth has been suggested.

DEVITALIZATION AND REMOVAL OF THE PULP.

With regard to the best means of destroying the pulp of the tooth, when it is impossible to preserve it, there exists much diversity of opinion. There are two methods by which this may be accomplished, one by immediate *extirpation* with an instrument and by *actual cautery*, the other by the application of some devitalizing agent, such as *arsenic*.

For the removal of the pulp by extirpation there are different forms of instruments employed, such as a three- or four-sided broach, barbed for some distance from the point, which is thrust as far up the pulp canal as is possible, then rotated and withdrawn, bringing the pulp with it. Fig. 127 represents a broach of this kind, which may be used with or without a holder. Another form of broach is used for this operation which is not barbed, but thrust into the pulp for the purpose of so lacerating it that it may afterward be removed with nerve instruments without much pain. A fine, round, steel wire, from which the temper has been drawn, and having a flat point bent on an angle of about forty degrees, is also used for extirpating the pulp.

The edge of the point, in introducing this instrument, is pressed against one wall of the canal and gradually forced up as far as it will enter, when it is suddenly turned so as to excise the pulp and on withdrawing the instrument bring the severed organ with it.

Figs. 128 and 129 represent excellent forms of instruments devised by Dr. R. B. Donaldson for cleansing pulp-canals and removing pulp.

For extirpating the pulps of the molar teeth a larger instrument is required, which is thrust into the pulp-chamber, and rotated so as to sever the body of the pulp from the branches filling the root canals. The small nerve instruments are then employed for removing these branches.

The operation of extirpation should depend upon the temperament of the patient and the condition and class of the tooth. Where such an operation would cause a severe shock, owing to a nervous, irritable temperament, it is best to employ the therapeutical method; on the other hand, where there is great power of endurance, and the tooth is

of a frail, chalky consistence, or threatened with periosteal inflammation, it is preferable to remove the pulp by an operation. The pain, however, can be greatly mitigated by the previous application of some

FIG. 127.

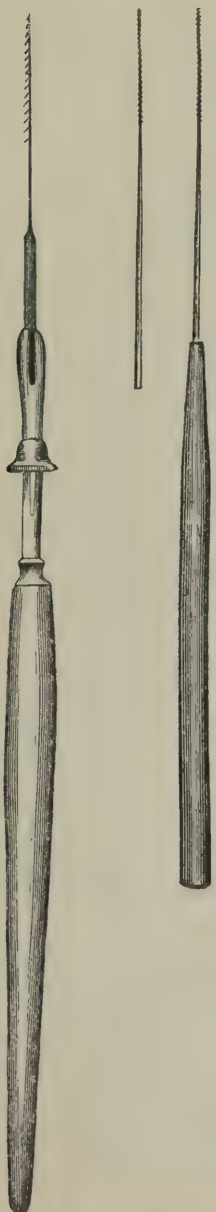


FIG. 128.

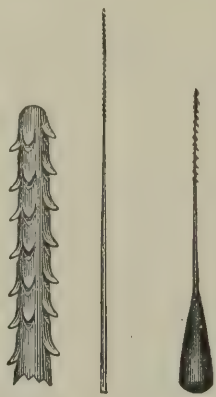


FIG. 129.

obtunding agent, such as sulphate of atropin, aconite, cocain, chloroform, or other local anesthetics.

In all cases, and by whatever method, the orifice of exposure should be large and nearly on a line with the axis of the tooth, so as to admit of easy manipulation, especially if the barbed broach or bent wire are employed; and when a pulp is removed by such an operation the wound usually heals by first intention, and no peridental irritation results.

The late Dr. Harwood, of Boston, who was strongly opposed to the use of arsenious acid as a devitalizing agent, described his plan of accomplishing this object by the surgical method, as follows:—

"I first effect such an opening as will enable me to approach the exposed pulp in the line of its axis, or as nearly so as circumstances will permit. Then, having carefully but sufficiently exposed the surface of the pulp, I pass down to the apex of the root, through the pulp, a small untempered steel instrument, with a trocar-shaped point, and revolving it once or twice sever the vessels and nerve. This, as any one knows who is accustomed to inserting artificial teeth, produces but a slight and momentary pain. I then, by means of minute instruments adapted to the purpose, endeavor to remove every portion of the severed pulp and lining membrane, and, as soon as the hemorrhage ceases, dry and fill the cavity.

"It should be borne in mind that at the point where the vessels and nerve in question enter the root the passage is much smaller than it is immediately within. This strait will be easily recognized, when reached, by the touch, the instrument appearing to be arrested by an obstacle, and not by being wedged in a narrow passage. Care should be taken, I think, that the instrument is not allowed to pass through the strait, either by being too small, or by being revolved there till it cuts its way through. For by wounding the parts without the tooth and forcing particles of bone out upon the parts external to the root the danger of an unfavorable result would be greatly increased."

The actual cautery consists in thrusting a wire, heated to a white heat, up the canal; but as this is considered a barbarous method, it is not resorted to by practitioners in this country. Besides, peridental inflammation is often a result of its use, and the pain following its application is sometimes very severe. The galvanic cautery is preferable to the actual cautery for the destruction of pulps, and is applied by means of a bent platinum wire maintained at a white heat.

Arsenious acid* has long been used in connection with acetate of

* The employment of arsenious acid for the destruction of an exposed dental pulp and the relief of the pain arising therefrom originated with the late Dr. Spooner, of Montreal; and in 1835 it was recommended to the profession by his brother, Dr. S. Spooner, of New York, in an excellent popular treatise upon the teeth.

morphin and creasote, or carbolic acid, to devitalize the pulp; the arsenic and morphin being mixed in equal parts and taken up on a small pellet of cotton saturated with creasote, which is introduced directly upon the exposed portion of the pulp, and the cavity filled with wax or cotton saturated with a solution of gum sandarach and alcohol. The morphin was formerly supposed to modify the irritating action of the arsenious acid; but since this has been discovered not to be the case, its use has been dispensed with by many who prefer no other combination than creasote or carbolic acid. Water, alcohol, and ether have also been employed as substitutes for the creasote. The arsenious acid is at times combined with an equal part by weight of pulverized charcoal, on account of the antiseptic properties of this latter agent and also on account of its mechanical action in preventing the dentine from absorbing what is intended for the pulp alone. A favorite mixture is known as "nerve paste;" but when a definite quantity of the arsenious acid is desired for application to a pulp it is better to employ the dry form. Various formulæ are in use for the preparation of devitalizing mixtures, such as equal parts by weight of arsenious acid and acetate of morphin; three parts by weight of arsenious acid to two parts of morphin; two parts of arsenious acid and one part of morphin. Creasote or carbolic acid is generally employed to combine the ingredients and also to act as a sedative. Although the thirtieth part of a grain of arsenious acid is the average quantity generally employed to devitalize the pulp, yet the amount may be reduced to the $\frac{1}{100}$ of a grain in many cases when judiciously used. The length of time the preparation should be allowed to remain varies from six to twenty-four hours. Dr. J. F. Flagg recommends the following formula:—

℞.	Arsenious acid, ...	gr. j.
	Acetate of morphin, ...	gr. ij.
	Carbolic acid, ...	gtt. iij.

A very convenient form of devitalizing mixture is that known as "nerve fibres," which consists of a combination of arsenic, creasote, tannin, and opium incorporated in the fibres of cotton or lint, which is afterward dried and cut up into shreds. Dr. James Gordon has suggested the following method of devitalizing pulps, which is claimed to be less painful than that heretofore employed: After carefully cleansing the cavity saturate a very small pledget of cotton, held by a foil carrier, with benzol, and then apply to the cotton a little nerve paste, and place the whole directly upon the exposed pulp and cover it by loosely filling the cavity with cotton saturated with sandarach varnish. If a solution of caoutchouc in benzol is employed to satu-

rate the first pledget of cotton to which the nerve paste is applied, the preparation will better retain its place in the cavity and is less liable to be displaced when the retaining pledget of cotton saturated with sandarach is introduced.

When arsenious acid is applied to temporary teeth the quantity employed should be very minute, and many are disposed to question the safety of its application to such teeth, as the agent may be absorbed by the very vascular structure and injure the surrounding membranes. Not unfrequently cases are met with where repeated applications of the preparation fail to destroy the vitality of the pulp, which is doubtless owing, in cases where the organ is fairly exposed, to its inflamed condition at the time the application is made, which enables it to resist the absorbent action of the arsenic. In such cases a preparation composed of tannin and creasote has proved serviceable.

Arsenic when applied to a pulp excites inflammation, and as this condition passes off the agent is absorbed and devitalization follows. Too great a quantity of arsenic will defeat the object, and in many cases its devitalizing action is prevented by the high degree of inflammation present, so that it is necessary to reduce the inflammatory condition before a successful application of the devitalizing agent can be made.

The time the arsenious acid is permitted to remain in the tooth is important, and should be determined by the condition of the pulp, the class of tooth, the structure of the tooth, the age of the patient, and the susceptibility to the influence of the agent. The time necessary for the action of arsenious acid varies from six to twelve and in some cases twenty-four hours, when minute quantities are employed.

As the degree of inflammation excited by the arsenic depends upon the quantity of the agent employed, it is much the safer and better plan to apply small quantities than an amount which will devitalize the pulp by one application ; for in the latter case there is danger of the effects being carried to the peridental membrane through the apical foramen.

It is often very difficult to retain the devitalizing agent on fractured teeth when it becomes necessary to destroy their pulps. A method pursued by some is to apply a minute quantity and cover it with gutta-percha, which is held in position by ligatures. Another method suggested by Dr. Rich is to secure the arsenical preparation by surgeon's rubber plaster, passing it around any portion of the crown which remains.

Dr. E. C. Kirk, whose experiments with coagulants in pulp-canals demonstrate very clearly that notwithstanding the care we may take in sealing drugs in the cavity of a tooth, we cannot prevent their exerting

more or less influence on the peridental membrane, suggests the following devitalizing mixture, which he states has given uniform satisfaction as a prompt obtunder and immediate relief from pain :—

℞. Acid. arsenic pulv., cocain hydrochlorat, āā . gr. xx.
Menthol cryst., ... gr. v.
Glycerin, ... q. s. M.
To make a stiff paste.

Dr. A. G. Johnson claims that the following formula has proven the best of a number experimented with :—

℞. Arsenious acid, ... gr. xx.
Hydrochlorate of cocain, ... gr. xxx.
Lanolin q. s. ft. paste.

Dr. James Truman recommends the following devitalizing mixture as prompt and painless : Take the amount of arsenic it is proposed to employ and add an equal quantity of iodoform, and on a glass slide, by means of a 5 per cent. solution of carbolic acid, make a paste. The whole is carried to the pulp on a piece of cotton the size of a pin-head, in which it is incorporated, and covered with a cap of platinum or of red gutta-percha, and over this a temporary filling of wax or cotton saturated with sandarach.

Another method is to saturate a piece of blotting paper with creasote, and on this place the least possible amount of arsenic, then a little powdered cocain, all of which is covered with wax or cotton saturated with sandarach varnish, avoiding any pressure on the pulp. This is permitted to remain in the tooth for two or three days.

Dr. George A. Mayfield's method of devitalizing pulp is as follows : Apply the rubber-dam, if possible, dry out the cavity, uncover the pulp by first blowing on warm air, then an application of a saturated solution of cocain in alcohol and ether or chloroform, equal parts, allowing this to remain about thirty seconds, then another application of warm air, continuing in this way till sensitiveness is wholly obtunded. As soon as the pulp is exposed, apply crystals of cocain and moisten with campho-phenique. After waiting thirty seconds, apply warm air, and work the crystals of cocain into the pulp, and in from two to ten minutes introduce the needle of the hypodermic syringe, and inject a 4 per cent. solution of hydrochlorate of cocain into the pulp, which can be done without pain. The piston of the syringe is forced down with a quick push, thus forcing the needle into the benumbed pulp. The pulp-chamber is then opened with burs, and the body of the pulp removed.

Such agents as nitric acid and carbolic acid are also employed to

destroy pulps ; the method being first to apply the carbolic acid to the exposed surface of the pulp, and then the nitric acid on a small disc of card-board cut a little larger than the orifice of exposure and retained for half a minute. After this is removed a second application of the carbolic acid is made, and the pulp removed from the cavity by means of a barbed broach. Some employ a fine splinter of wood dipped in nitric acid, which is thrust into the previously obtunded pulp. Repeated applications of carbolic acid, chlorid of zinc, nitrate of silver, or caustic potash are also preferred by some to arsenious acid for devitalizing agents. A piece of hard elastic wood, shaped to conform to the pulp-canal, which is freely opened, and suddenly forced up on the pulp by the blow of a condensing hand-mallet, is recommended as being almost painless.

CHAPTER VII.

SENSITIVENESS OF DENTINE.

WHILE inflammation of the soft tissues exhibits such symptoms as pain, redness, heat, and swelling, the dentine of a tooth in a similar pathological condition does not indicate all such manifestations; for, owing to its peculiar structure, there is no redness, on account of a want of red globules, nor swelling, on account of the density. There is, however, exalted sensibility, and to such a condition the term inflammation has been applied. Inflammation of the dentine is due to exposure of this structure consequent upon the breaking down of the enamel or protective covering, and its degree will depend upon the organic structure of the teeth, susceptibility to irritation, and the nature of the irritating agents. Teeth that are very vascular and highly organized are often extremely susceptible to the action of irritating substances, and such a state of exalted sensibility may at times be occasioned by disturbance of other and remote organs, such as the uterus, for example.

The direct cause of inflammation of the dentine is irritation of the fibrillæ, which occupy the dentinal tubuli and are processes from the odontoblasts, and proceed through these tubules to the periphery of the dentine, and, in some cases, even beyond this structure. The odontoblasts are arranged in a layer on the outer surface of the pulp, and slight irritation of the ends of the fibrillæ, which proceed from these cells, results in the formation of secondary deposits of dentine.

The greatest sensitiveness is generally found where the union of the dentine with the enamel occurs, for the reason that at this point the fibrillæ on terminating bifurcate on the periphery of the dentine, and are more closely arranged, which accounts for the greater sensitiveness of dental caries in its incipient stage, and also for the increased sensitiveness of the dentine at its periphery.

Dr. Bödecker and others claim to have proved that the fibrillæ and their coarse offshoots are formations of living matter, and that the basic substance, which is so rich in lime salts, is traversed by an extremely delicate filigree of living matter. Dr. Herbst has also shown that only a portion of the pulp tissue left alive in the pulp-canals is capable of preserving the life of the dentine and enamel.

Dr. Bödecker,* in accounting for the transmission of pain through the dentine, says: "Nerves are made up of living matter, and owing to their reticulated or beaded structure, are fittest for that transmission of contractions" (living matter being contractile tissue, according to Heitzman) "from the periphery to the nervous centers which we call sensation. Contraction of the dentinal fibres transmitted into the reticulum of the protoplasm at the periphery of the pulp, and thence into the ultimate nerve fibrillæ,—all of which formations are proven to be continuous,—are sufficient to explain the transmission of sensation—pain."

A tooth is sometimes exceedingly sensitive when the pulp is not exposed; but, in the majority of cases, this need not deter the operator from removing the decayed part and filling the cavity, for the inflammation of the dentine may be confined to a thin lamina directly beneath the carious matter, and the only inconvenience it will occasion the patient will be a little suffering during the operation, and slight momentary pain for a few days, whenever anything hot or cold is taken into the mouth. A sharp, thin instrument rapidly used with skillful touches will often prove effective. But when the sensibility is so great that the patient cannot bear the removal of the diseased part, as occasionally occurs, it may be allayed by the application of chlorid of zinc to the cavity of the tooth for from three to six minutes. When this is done, care should be taken to prevent it from coming in contact with any of the soft parts of the mouth, on account of its active escharotic properties.

For the destruction merely of morbid sensibility in the solid structures of a tooth, chlorid of zinc is one of the oldest agents employed for such a purpose. Although a powerful escharotic, it does not, as all arsenical preparations are liable to do, produce any deleterious effect

* "Anatomy and Pathology of the Teeth."

on the pulp of the tooth. It is thought, however, in some cases to modify the texture of the dentine; and, in the opinion of some practitioners, so much so as to render it more easily acted upon by decaying agencies. When first applied it excites a sensation of heat, followed by burning pain; but these soon subside, and on removing it from the tooth the parts of the cavity with which it was in contact will, in a large majority of the cases, be found totally insensible to the touch of an instrument.

The chlorid may be applied directly to the cavity of a sensitive tooth, without being combined with any other substance, on a little raw cotton or lint; or it may be made into a paste by mixing it with an equal quantity of flour, the moisture which it absorbs from the atmosphere being sufficient for the formation of the paste; or it may be mixed with a little pure anhydrous sulphate of lime in an impalpable powder and then applied to the tooth. But before this is done as much of the decomposed dentine as possible should be removed, and the application should be held firmly in contact with the part of the cavity on which it is intended to act. A single application will generally suffice to destroy the sensibility to a sufficient depth as will enable the operator to remove any remaining portions of decayed dentine without pain; but repeated applications are sometimes necessary.

Tannin or tannic acid in alcoholic solution, or in creasote and glycerin, are valuable applications for this pathological condition of the dentine. Nitrate of silver, chromic acid, and the terchlorid of gold are also used for the same purpose—the nitrate being applied in either a solid form or in a concentrated solution; and while it affects the dentine to a greater depth than either the tannic acid or chlorid of zinc, yet its action is not so painful as the latter.

Creasote and carbolic acid, either alone or combined with acetate of morphin or tannic acid, are extensively used for this condition of dentine, and are among the safest of these agents.

Chloroform applied to the cavity on a small piece of cotton will often give a temporary insensibility, and has the merit of being quite harmless; which cannot be said of chlorid of zinc, arsenic, or cobalt —the first sometimes acting injuriously upon the dentine, the two latter upon the dental pulp.

A mixture of chloroform and aconite, equal parts, is also recommended; also, carvacrol, oil of cloves, oil of cedar, oil of eucalyptus, glycerin and tannin, creasote and tannin, camphor and chloral solution, camphorized ether, oxid of calcium (this latter, however, causes considerable pain when first applied), carbonate of sodium, menthol, thymol, the sesquichlorid of chromium, a mixture of equal parts of tincture of aconite and a saturated solution of iodin, carbonate of

potash, equal parts of sulphate of morphin and gum camphor, ethylate of sodium, carbonate of potash and glycerin, equal parts of crystallized carbolic acid and caustic potash, made by mixing into a crystalline paste and known as the "Robinson Remedy," and the insertion of temporary fillings composed of oxychlorid of zinc or oxyphosphate of zinc, or Hill's stopping.

FIG. 130.

The desiccation of the sensitive surface by heated air, so far as is possible, is also of great benefit. When this method is employed all moisture is excluded and the air injected by a hot-air syringe, the blast being gentle at first, and applied at intervals of a few seconds, and as the pain diminishes the force is increased at shorter intervals until the pain ceases, when the operation can be proceeded with.

An efficient means for the application of heat as an obtunder of sensitive dentine is the "Dento-Electric Cautery," represented in Fig. 130. The looped-wire of this instrument is rapidly passed across the sensitive surface, and obtunds it to such a degree as to produce an immunity from suffering of considerable duration.

In the instrument a platinum loop, A, is held by set-screws, B, in contact with metal conductors which pass through a hard-rubber handle. The battery wires are coupled to the two terminals, C. The appliance is held in the hand somewhat in the same manner as a pen or pencil in writing, and the circuit is closed by pressing upon the spring, D, with the forefinger, when the resistance of the loop causes it to become heated. The platinum loop when destroyed is readily and inexpensively replaced.

A safe way of meeting the difficulty in slight cases is to have the excavators and burs very sharp and well tempered, and to cut firmly and decidedly (for the scraping of a dull instrument is quite as painful as the cut of a sharp one), making cuts "which sweep the circumference of the cavity," or in a direction from the pulp chamber.

Friction, by means of a burnisher, is also recommended as being effectual where the position of the sensitive surface will permit of its use.

When painful escharotics are employed, the sensitiveness of the dentinal surface should first be obtunded by the application of a solution of sulphate of atropin, or other local anesthetic.

When local obtunders are inefficient, or from the nature of the case

cannot be applied, the inhalation of sulphuric ether has been resorted to with beneficial results.

Having noticed the agents usually employed for destroying morbid or hyper-sensibility in dentine, we will proceed to notice a few of the non-conductors against thermal influences that have been used for the accomplishment of the same object. Among the substances which have been employed for this purpose are *asbestos*, *gutta percha*, *cork*, *oiled silk ;* also such filling materials as *Hill's stopping*, chloro-percha, the *oxychlorid* and *oxyphosphate* of zinc.

Asbestos, as a non-conductor of caloric, certainly possesses every desirable property, and is as indestructible in a tooth as gold. When used for this purpose the purest variety should be selected. A small pellet made from the filaments of this mineral, placed in the bottom of a cavity previously to filling, will effectually prevent irritation of the pulp from impressions of heat and cold. The cavity, however, should be first properly prepared, washed with tepid water, and made perfectly dry. The asbestos may occupy from one-fourth to one-sixth of the depth of the cavity after the filling has been introduced and consolidated.

A thin layer of gutta percha placed in the bottom of the cavity, previously to introducing the gold, is as effectual in preventing the transmission of impressions of heat and cold as asbestos, and can be more conveniently applied. There is, however, a preparation of it, known as "Hill's stopping," which is better than the simple article for a temporary filling.

Cork is an equally good non-conductor of caloric, but some object to its use on account of its being more destructible than asbestos or gutta percha; but cut off, as it necessarily would be in the bottom of the cavity beneath the filling, its liability to undergo any change would seem to be rendered wholly impossible. But it is of a more porous nature than gutta percha, and cannot be adapted as perfectly to the inequalities of the floor of the cavity. There is also danger, in introducing the filling, of forcing some portions of the gold through it, unless a very thick piece be used. Oiled silk has also been used in some cases very successfully, but it is not as good a non-conductor as either of the afore-mentioned agents. Mastic, copal and other varnishes are also used as non-conductors in sensitive cavities prior to the introduction of the metallic filling.

The filling materials known as oxychlorid of zinc and oxyphosphate of zinc often prove effectual in preparing a sensitive cavity for a more durable metallic filling. For the method of applying these agents, and also Hill's stopping, the reader is referred to the chapter on "Materials Employed for Filling Teeth."

Should it, however, be necessary to fill the cavity with a more permanent material, such as metal, and the inflammation is confined to a portion of the dentine, this may be protected by a layer of the non-conducting material and the metal introduced over it.

CHAPTER VIII.

TUMORS OF THE MOUTH AND JAWS.

Tumors of the gums are of various kinds; some interesting cases of simple hypertrophy are reported by Dr. Gross and Mr. Salter and Mr. Erichsen which are reproduced by Mr. Heath in his admirable "Essay." Mr. Salter's case was found to consist of a pinkish, corrugated, and lobed mass, composed of an expansion of the alveolus, with "immense hypertrophy of the fibrous gum, and an exuberant growth of the papillæ of the mucous membrane." Dr. Gross's case was somewhat similar. Mr. Erichsen's was found, "on section, to consist of firm, fibrous stroma, containing much glandular tissue in its interstices, and covered on its surface by very large and vascular papillæ. The epithelial layer was of unusual thickness, but no abnormal epithelial structures were found in the growth, which was an example of true hypertrophy." (Heath's "Jacksonian Essay," 190.)

A peculiarity of this case was that the teeth were also hypertrophied. In each of these cases the diseased tissue was removed and the exposed surface cauterized.

Polypus is a simple hypertrophy of the interdental gum, or dental pulp, and is generally occasioned by the irritation of a worn-out or broken tooth with a ragged edge. In structure these growths are like the gum from which they arise. They seldom give much pain, except ulceration should take place. If simply cut away they are very likely to return, but if the tooth is removed and astringent or cauterant applications be made they give but little trouble.

Continuous pressure by gutta percha or other means will also control them.

Mr. Salter reports two cases of "Papillary Tumors of the Gums," consisting almost entirely of epithelium, arranged in filiform papillæ resembling those of the tongue. It is described as "a curious white mass, consisting of coarse, detached fibres, pointed and free at one extremity and attached at the other; in fact, it was a mass of papillæ, many of them nearly an inch long, and similar in shape to the 'fili-

form' papillæ of the tongue; their surface was shreddy and broken; among the elongated processes were a few rounded eminences like 'fungiform' papillæ, and these had a smooth and broken surface."

The term Epulis is usually applied to tumors springing from the margin of the gums, whatever their structural character. They most commonly spring from the gum between two teeth; as they continue to grow the base may increase also in size till it covers the alveolar bone, or it may undergo superficial development, the point of attachment undergoing but little change; in other words, it may possess a broad, flattened base or a narrow pedicle. In structure it bears a close resemblance to the gum, and sometimes has imbedded in it spiculæ of bone, which may have been detached from the alveolar bone, constituting the source of irritation which gave rise to the morbid growth; or it may have been a true osseous development; a portion of germinal matter, having escaped from its true osseous relation, has been here arrested, established a false center of growth, and undergone development, in obedience to the primitive impulse of the parent cell from which it was derived.

Fig. 131, from Mr. Heath, is a typical epulis of the most common variety. It is seen to be a "firm fibrous tumor," with "some fibroplastic cells intermingled." This variety of epulis is not unusually attached to the periosteum of the alveolus, with projecting spiculæ of bone entering it from the maxilla.

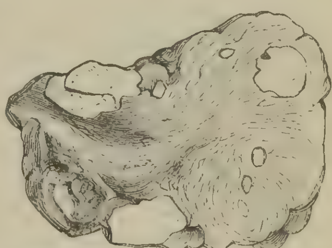


FIG. 131.—(Fig. 90 of "Heath on the Jaws.")

Left to themselves, these tumors will often continue to grow, encroaching upon the tongue, hard palate, and teeth. They are thus made liable to injury by the teeth, and an ulcerated surface is in this way established, which discharges freely, occasions considerable pain, and may become the seat of hemorrhage.

A softer and more vascular variety is described by Mr. Hutchinson as consisting of fibrous tissue, in which are imbedded a large number of polynucleated cells of the myeloid variety. In the "Transactions of the Pathological Society" he thus describes them: "The epulis presented all the characters of myeloid growth in a most remarkable degree. Its section was very vascular, and showed hues varying from a deep red to buff, and a peculiar light-greenish tint of yellow (xanthoid of Lebert). Scattered in its structures were some detached masses of soft, spongy bone. Under the microscope were seen an abundance of the large polynucleated bodies characteristic of these

growths, many of them being very irregular in shape and much branched." This form of epulis is most frequently connected with the interior of the alveolus, and hence more closely resembles the endosteal structures. When presenting an ill-conditioned and ulcerated surface, it closely resembles a malignant growth, but does not, as has been thought by some writers, pass into cancer.

Mr. Heath also describes a variety which he calls "giant-celled epulis," consisting of "large, irregular, disc-like cells containing numerous beard-like nuclei interspersed among the fibrous tissue." It presents a surface of uniform smoothness, of a dark-gray color, with numerous purple spots upon it. He considers it as holding a position intermediate between "fibro-cellular and myeloid tumors," and of a similar nature to the growths described by Otto Weber as "giant-celled sarcoma," and as a "fibrous form of cancer arising from bone" by Wedl.

Another form of epulis, resembling epithelioma, and of interest as showing that epithelioma may be developed in the gum as elsewhere, is thus described in a report by Mr. Bruce to Mr. Heath :—

"The surface of the tumor is covered with healthy mucous membrane. The interior of the tumor is whiter, firmer, and more compact than the surface, but there is no line of demarcation between the tumor and its mucous covering. The structure of the growth is distinctly glandular, very much resembling some form of compact adenoid tumor of the breast.

"At the point of attachment of the tumor to the parts beneath a remarkable transformation of the glandular into the epitheliomatous structure is seen. In one part of the section may be seen the cut ends of gland tubules, whilst in their immediate neighborhood are most distinct nests of true epithelioma, consisting evidently of concentrically arranged cells compressed from the center upward."

Mr. Adams reports a similar case which resulted in death, the disease having reappeared in the skin after its removal.

It is often difficult to determine the causation of epulis, but they may often be referred to the irritation of broken or unsound teeth, or to fragments of the alveolar bone which become detached, or to outgrowths from the alveolus ; most frequently, however, to roots of decayed teeth ; hence, Mr. Heath thinks, the greater frequency of these tumors in women—five to three—they, having a greater dread of all surgical operations, are more likely to permit useless roots to remain in their mouths.

It is rarely fatal, but sometimes attains such size as to produce great deformity, pain, and embarrassment of the functions of mastication and deglutition.

For the treatment of epulis, nothing short of the entire removal of the tumor with its periosteal attachments, together with all decayed teeth, or even sound ones—when the disease seems inclined to reproduce itself—promises any good result. After excision, the actual cautery should be freely applied, for the double purpose of destroying all trace of the disease and of arresting hemorrhage.

Tumors of the hard palate are closely related to epulis, and papillary and epithelial forms are reported—the former presenting but little difference from tumors of the same character arising on the gum.

An epithelial tumor occurring on the hard palate is reported by Dr. Andrew Clark, which was described as "soft, elastic, and vascular. The cut surface is of a dead-white color, distinctly granular, like rough honey, crumbly-looking, and studded with red or pink blotched parts sunk below the general level. On further examination it appears to be permeated by a kind of glairy substance (colloid matter), which helps, seemingly, to give coherence to the tumor. To the naked eye the tumor resembles in some respects a cephaloid or myeloid mass. To the latter it bears the greatest resemblance in general character, seat, and structure. The microscopic characters are those of epithelial cancer, epithelial cells in all stages of development and of the most various forms, together with a few nest-cells and fat. The mucous membrane over the tumor, though not continuous with it, presents the same structural characters. This decides the doubt between the epithelioma and myeloma." (Heath's "Jacksonian Essay," p. 208.)

Encysted tumors of the hard palate are also sometimes found, but they are rare, and require no special description in a work of this character.

These tumors, when epuloid in character, are to be treated in the manner already described. When the bone becomes affected, it also must be removed to such an extent as will leave an entirely healthy surface.

Unerupted teeth may also give rise to osseous tumors, requiring surgical interference. This is more peculiarly the case with the wisdom tooth, for a reason easily understood: the space nominally allotted it, between the second molar and the terminal point of the alveolar ridge, is often too limited for its eruption; endeavoring to make its way through the bone under such circumstances, the opposition it encounters is often sufficient to occasion great irritation and pain, and occasionally to entirely prevent its eruption. The retained tooth thus becomes a center of irritative action, and may serve not only to determine the site, but the fact of such tumors. Mr. Tomes also relates a case in which the wisdom tooth was bound down by a "mass

of enamel, dentine, and cementum, thrown together without any definite arrangement," which occupied the place of the second molar. Mr. Heath also records a case, reported by Dr. Forget, in which a tumor about the "consistence of ivory," covered everywhere with enamel, and about the size of an egg, occupied that portion of the jaw between the ramus and the first bicuspid. It was composed chiefly of enamel and dentine, with portions of cementum "dipping into the crevices" here and there, and was regarded by Dr. Forget as a "fusion and hypertrophy of the last two molars."

Again, one of the anatomical elements of the tooth may become so hypertrophied as to constitute a troublesome disease and call for surgical interference. The cementum is most likely to undergo such change. M. Maisonneuve reports a case cited by Mr. Heath, in which the hypertrophied cementum attained the size of a pigeon's egg.

It is desirable, if possible, to remove all such morbid growths without injury to the bone in which they are implanted; but it may become necessary to excise that part of the jaw in which it is. All neighboring teeth which may possibly be associated with it should be removed.

Tumors of the antrum and upper jaw may be appropriately described together, the distinguishing characteristics being pointed out.

Polypus.—Growths of this character occasionally occur in the antrum, and are closely allied to the small cysts occurring in its mucous membrane; both are essentially a "hypertrophy of some element of the mucous or sub-mucous tissue. When the connective or areolar tissue predominates, the fleshy polypus is produced; when the glandular element is especially affected, we have the cystic form produced. Intermediately, when the fibrous element is very loose and we have some glandular hypertrophy, the semi-gelatinous polypus is produced, which closely resembles the nasal polypus." ("Jacksonian Essay," p. 210.)

Antral polyps are very vascular, and are sometimes the ushers of malignant disease. The diagnosis is exceedingly difficult until they have advanced sufficiently to break down the osseous wall somewhere; this most frequently takes place into the nose, through the thin nasal wall.

They should be removed as soon as ascertained to exist, and the troublesome hemorrhage which is likely to occur should be arrested by injections of a reliable styptic, in any strength which is not likely to give rise to trouble, if the opening is sufficiently large to permit its ready escape.

A single instance of a peculiar form of fibroid growth of the antrum

is recorded by Mr. Heath, from whose work we take the following description by Mr. Bruce :—

"It appears to consist of a fine, soft, fibrous stroma, in which very numerous nuclear bodies and a few elongated fibre-cells are distributed. Its structure resembles that of the upper strata of a mucous membrane, from which it is probably an outgrowth. It consists of newly-formed fibrous tissue, and of the elements from which fibrous tissue is developed, and may, therefore, be classed among the simple fibro-plastic growths as distinguished from the true myeloid tumors."

Fibrous tumors of the upper jaw are not unlike fibrous tumors found elsewhere. They are slow of growth, dense in structure, with interlacing, slender bundles of fibres, and are frequently lobulated. They commonly spring from the interior of the antrum or from the alveolus, and sometimes attain to an enormous size, crushing in the antrum or obliterating its walls by absorption, encroaching upon the orbit, destroying its floor, penetrating the nasal cavity, and, extending outward, conceal the teeth on the same side from view. Mr. Liston removed a tumor of this kind from the face of a lady, where it had arisen six years before, apparently from a blow received on the face, and had attained to an enormous size, covering the whole of that side of the face. Its smallest diameter was six inches. This tumor became of increased vascularity after the cessation of the catemenia at the regular monthly period, and bled slightly at these times from the adjacent parts of the gum. They are usually of an oval or rounded form, freely movable, and painless. When laid open they present a white, shining, ligamentous structure, and are composed of nucleated fibres. If left to themselves they may become softened in the center and undergo disintegration, though Mr. Heath thinks they never suppurate except where they have been punctured in establishing a diagnosis. They may also undergo calcareous degeneration, but are never ossified.

Mr. Paget reports a case in which distinct pulsation, synchronous with the radial pulse, was felt. They rarely recur after removal, perhaps never when entirely removed. Mr. Weber thinks "they are usually connected with the lining of the Haversian canals," and advises that a portion of the bone be removed in all operations. Their origin is usually referred to the irritation of decayed teeth or to direct violence.

Fibro-cellular tumor, or osteo-sarcoma, is of softer consistence than the simple fibrous tumor; they are smooth, round, elastic tumors, of a yellowish color, and are infiltrated with a serous fluid. Unlike the simple fibrous tumor, they exhibit a strong tendency to ulceration, which sometimes serves to confound them with malignant growths, from which they are to be distinguished by the history of the case and

the non-implication of the lymphatic glands. They are thus described by Sir Philip Crampton: "In the earlier stages of the disease the tumor consists of a dense, elastic substance resembling fibro-cartilaginous structure, but the resemblance is more in color than consistency, for it is not nearly so hard, and is granular rather than fibrous, so that it '*breaks short.*' On cutting into the tumor the edge of the knife grates against spicula, or small grains of earthy matter, with which its substance is beset." Fibro-cellular tumors may undergo fatty or calcareous degeneration.

Recurring fibroid tumors occur, if at all, so rarely in the upper jaw, that any description is unnecessary in a work of this kind. The same may be said of vascular tumors.

Myeloid tumors are described by Mr. Paget as occupying an intermediate position between fibrous and fibro-cellular tumors. They are composed of parallel fibres, with fibro-plastic cells, and bear a close resemblance to "granulation cells in process of development into fibro-cellular tissue." On section they present a smooth, shiny, semi-transparent appearance; are of a pinkish or bluish color and of brittle texture. They usually occur in the young, are painless, and seldom recur. Externally they present a dark maroon color, quite characteristic. An excellent description of a tumor of this class is furnished Mr. Heath by Dr. Tonge, from which we make the following extract: "It was of firm consistence throughout, and on section presented a whitish appearance, with a small pink patch or two, and a whitish, creamy-looking juice could be scraped from the cut surface. . . . The fibrous element was much less abundant than the cellular, and consisted of white fibrous tissue, with numerous fine, curling fibres of yellow elastic tissue, and many small oval and rounded nuclei were imbedded in the fibrous structure. The greater portion of the tumor seemed to be composed of cells. These were mostly of an irregularly rounded form, often with pointed processes; and some shuttle-shaped and spindle-shaped, of a somewhat trapezoidal form, were not uncommon, while a few cells presented the character of those distinctive of myeloid tumors. All the cells contained one, and often two, very large and generally oval nuclei, with one, two, or three nucleoli, and a variable number of oil globules. The myeloid cells observed were of irregular outline and contained from three to five nuclei, with single or double nucleoli; one very large cell contained six nuclei."

Their formation takes place slowly, after the manner of cyst formation or other simple tumors. When the bone has been removed by absorption or otherwise they may be recognized by their characteristic color, and when a cyst forms within them, as sometimes happens,

myeloid cells may be found in the fluid that escapes when it has been punctured, thus distinguishing it from cystic formations.

Cartilaginous tumors are of two kinds: simple, innocent, or benignant tumors, and tumors presenting a malignant appearance. Those of the first class present a round or ovoidal form, are smooth, hard, of slow growth, and painless. Those of the second class grow with great rapidity, to a large size, and are of a malignant appearance.

Cartilaginous tumors occur on the upper jaw, but may affect it secondarily by extension from other parts.

Mr. Heath describes specimens taken from St. George's and St. Bartholomew's Hospitals, in one of which the disease occurred on the inner side of the orbit, and two years later had pressed the superior maxillæ forward nearly an inch beyond the inferior, while the "bones of the face and orbit were extensively absorbed." In the other the superior maxillary bones were entirely absorbed, the cavity of the skull was invaded, and the brain pressed aside; it is attached to the soft palate below, and presses forward the walls of the nose in front. Mr. Paget relates a case in which the disease had existed nine years, was removed, but returned, and the patient died seven years after. "A section of the tumor showed that it was composed of an outer, hard, thin shell of bone, completely enclosing a morbid growth of spongy, cancellated structure, devoid of all appearance of carcinomatous or spongy disease." These growths are usually very slow, and when removed exhibit but a slight tendency to recur. Cases are reported in which the free local use of iodin has effected the absorption of tumors of this kind that had not yet attained a large size. They sometimes soften, disintegrate, slough, and establish fistulous openings, through which a jelly-like mass escapes.

Osseous tumors in their simplest form are but a hypertrophy of previously existing bone tissue. They are predisposed to by syphilitic and scrofulous affections, and sometimes their immediate origin may be traced to the irritation of imperfect teeth; in general, however, it is difficult to refer them to a determinate cause. They are of slow growth, painless, and closely resemble true bone in structure. Their slowness of growth, hardness, painlessness, and fixity are the characteristics on which a diagnosis may be based, though they are occasionally movable. Occasionally they ulcerate, and troublesome fistulous openings are established. When of a large size they may invade important organs, occasioning great trouble, as in the case reported by Mr. Hilton, where it invaded the orbit and by its pressure burst the ball of the eye.

Cancerous tumors of the upper jaw are, in Mr. Heath's experience, limited to the medullary form; other observers have, however, occa-

sionally met with schirrhus. Mr. Hancock advanced the view that medullary disease does not begin in the antrum, but in the bones at the base of the skull. This view is refuted by the observation of Mr. Liston and others, who have shown that it unquestionably begins in the antrum very often. They are characterized by rapid development, softness to the touch, and, when fully established, by a peculiar expression and sallow, putty-like appearance of the skin. In this situation it is seldom accompanied by glandular enlargement. By pressing upon the nasal duct it may occasion considerable edema of the lower eyelid, with enlargement of the facial veins, from obstructed circulation.

For the cure of all solid tumors of the upper jaw there is but one remedy on which we can rely—the knife. All operative procedures should be resorted to at the earliest practicable moment, before the facial structures have been extensively invaded by the disease. When the disease is entirely removed, in even malignant growths, we may sometimes entertain a hope of permanent relief. To effect the removal of tumors in this situation various methods have been devised. Until 1826 surgeons usually contented themselves with the removal of so much of the disease as could be effected with the gouge and chisel; but about this time Mr. Lizars, of Edinburgh, proposed the removal of the entire superior maxilla, having previously secured the carotid artery. An opportunity to carry out his suggestion did not offer until December of the following year, when, in attempting this operation, the hemorrhage, notwithstanding the ligation of the carotid, was so great as to necessitate the discontinuance of the operation. In the meantime, without any knowledge of Mr. Lizars' suggestion, Mr. Gensoul successfully removed the upper jaw without securing the artery and with but little hemorrhage. Mr. Lizars afterward operated successfully, and the operation is now an established one. His incision was carried from the angle of the mouth to the malar bone, where, when more space was required, it was met by a short, vertical incision, and an incision was also made from the middle line of the lip to the nostril. Mr. Gensoul employed a vertical incision from the inner canthus to the angle of the mouth, which was met midway by another at right angles to it, letting fall on its outer extremity another vertical incision. The bone was then removed with the mallet and chisel. An obvious objection to these operations was the great deformity occasioned and the division of the facial nerve. To obviate these difficulties Sir William Fergusson suggested a plan, which has since been very generally adopted. It consisted solely in an incision from the middle line of the lip to the nostril, when, by stretching the integument, sufficient space was usually gained. If more, however,

was required, the incision was carried up alongside of the nose to the inner canthus, and below the eye to the outer canthus; thus the facial nerve and artery were divided so high up as to give but little trouble, while the scars are most favorably situated (see Fig. 132).

After deflecting the skin, a small saw is passed into the nostril, with which the hard palate and alveolus are divided. The nasal and malar processes of the superior maxilla are next sawed nearly through, and the division completed with bone forceps. The bone is then grasped by the powerful forceps devised by Sir William Fergusson, and forcibly wrenched from its attachments to the pterygoid process and palate bones. The infra-orbital nerve is then divided, the soft palate carefully dissected from the detached bone, which is ready for removal, after which hemorrhage is arrested by ligatures and the actual cautery, and the wound closed with silver sutures. When the palate bone and orbital palate are not involved they may be spared by sawing horizontally above and below them respectively. Sir William Fergusson now prefers to avoid the removal of all healthy tissue by attacking the disease from center to circumference with strong curved and angular bone forceps. Both superior maxillæ have occasionally been removed; but it is an operation so seldom required that a description of it is not called for in a work of this kind.

FIG. 132.

Tumors of the lower jaw do not differ in essential particulars from those already described. They are more readily diagnosed and safely removed than those of the upper jaw. Deaths are comparatively rare from operative procedures here. When the tumors are small they may be removed without incision of the lip by simply dissecting them from their attachment to the bone, turning them down, and removing the diseased portion with bone forceps. When a large body is to be removed the incision should be carried beneath the margin of the jaw, where the scar shall afterward be concealed from view. When the bone is exposed we should endeavor carefully to ascertain if the disease may

not be removed with the external plate of bone alone; if this may not be done, the saw should be brought into requisition and the diseased structure removed. Amputation of the lower jaw is far more readily effected than of the upper. For a detailed account of this operation the student is referred to more exclusively surgical works.

CYSTIC TUMORS, DENTIGEROUS CYSTS.

It must be remembered, in connection with diseases of the antrum, that it is of variable size, with walls of variable thickness. In youth the walls are thick and the cavity small. After attaining its maximum size in the adult it is found again to diminish with old age; it is larger in males than in females. But in adult life its capacity varies in different subjects, from one dram to eight drams, the average capacity being about two and a half drams.

Suppurative inflammation, or abscess of the antrum, is commonly due to extension of inflammation from the teeth to the lining membrane of its cavity. The roots of the first and second molars not infrequently present prominences at the antrum, and sometimes the first molar roots are found extending into this cavity entirely uncovered by bone. It will, therefore, be readily seen how disease of the roots may prove a source of irritation and inflammation to the lining membrane of this cavity; but such direct communication is not necessary; and disease beginning in alveoli not in immediate relation with the antrum may extend through intervening bone and establish communication. Direct blows upon the face may also induce suppurative inflammation of its membrane, and it may also arise from "pressure during birth."

The symptoms are, pain of a dull character, shooting up the side of the face and head, rigors succeeded by irritative fever, with tenderness and swelling of the cheek. As the pus accumulates, the pressure to which it subjects the walls of the cavity, together with the vitiated nutrition occasioned by its presence, determines absorption of the bone and the discharge of the contained fluid through the opening thus established either into the orbit or by the side of the teeth. Before an opening is established, however, the orbital wall may become so dilated as to occasion partial blindness by displacement of the eye, or it may even induce an amaurosis which shall result in permanent blindness. Sometimes extensive necrosis is occasioned, affecting all the adjacent bones, as in the case reported by Mr. Salter, in which the "floor of the orbit, the upper cheek portion of the superior maxilla, and the infraorbital, and a large plate of bone from the inner (nasal) wall of the antrum, were involved." Dr. Mair, of Madras, reports a case in which death resulted in sixteen days, though apparently begin-

ning as a simple ozena. The post-mortem examination in this case revealed a condition of things that led Dr. Mair to conclude that it began as a "disease of the antrum, originating in degeneration of the mucous membrane lining its cavity, or, perhaps, connected with the soft tumors which grow from the apex of the tooth and from the lining membrane of the root; secondarily, involving the ethmoid, lachrymal, palatine, and inferior turbinated bones of the left side, causing suppuration and disintegration, the purulent matter filling the cavity of the antrum extending toward the left nostril, causing ozena, and upward into the orbit, behind the globe of the eye, pushing the eye outward and forward, the matter finding its way through the optic foramen to the anterior surface of the left hemisphere of the brain, there acting as a foreign body, exciting inflammatory action, terminating in cerebral abscess, causing convulsions, coma, and death." (*Edinburgh Medical Journal*, May, 1806.) Cases of such severity are, fortunately, rare; but they indicate the possibilities of the apparently most simple cases, as well as the line of treatment most likely to obviate such conditions and result.

Treatment.—In the simplest cases in which suppuration of the antrum is strongly suspected, we should at once remove all decayed teeth or roots, and even sound teeth, when found to be tender. If matter has not yet formed, the disease may then subside under the use of simple fomentations. It is safer, however, in most cases, to penetrate the antrum, preferably through the socket of the first molar, because of the greater depth of the socket; and this, too, without delay, care being taken to regulate the force so as not, by too great violence, to injure the floor of the orbit. Should the teeth be sound and it be desired to save them, an opening may be made through the alveolus above the gum. The cavity should be freely injected with tepid water, and subsequently with some slightly stimulating and antiseptic lotion; and care must afterward be taken to prevent the admission of foreign substances into the cavity.

In the more chronic forms of this disease the purulent accumulation takes place so slowly, and the consequent expansion is so gradual, that it is often mistaken for solid growths; and in many cases the diagnosis is of extreme difficulty; surgeons of distinction, having begun an operation for the removal of a solid growth, have been surprised to find their hands bathed in pus, whilst the supposed tumor disappeared from beneath them. In all cases in which the diagnosis is not perfectly clear an exploratory puncture should be made, and thus the difficulty is at once resolved.

Sometimes the pus is enclosed in a second bony investment, due to the ossification of the antral periosteum. When this occurs, it

occasionally happens that the bone remains thickened long after the evacuation of the pus and the entire cure of the abscess, the deformity, of course, remaining unaltered. It then becomes necessary to open the antrum and remove this ossified periosteum.

A clear or yellowish serous fluid is not unfrequently found in the antrum, which the older writers took to be a secretion of mucus, which, having failed to make its escape by the aperture between the antrum and the nostril, accumulated in such quantity as to occasion wasting of antral walls to such an extent as to permit the fluctuating mass to be felt at certain points. This fluid was found on examination to contain numerous flakes of cholesterin, as is the case in well-defined cystic growths, and, as it in no respect resembled mucus, recent writers have referred this form of disease to cystic formations.

The most recent and able writer on this subject, Mr. Heath, thus describes their mode of origin: "It is certain, however, that some of these cases, and very probably all of them, originate in the growth of a cyst, or cysts, within the antrum or in connection with the fangs of the teeth, which either grow to such a size as to be mistaken for the cavity of the antrum when opened, or break into the antrum by absorption of the cyst-wall, so that on subsequent examination no evidence of the cyst formation can be discovered."

These cyst formations are also occasionally mistaken for solid growths, and Mr. Heath relates an instance in which "a very able surgeon removed the upper jaw before the mistake was discovered." And Sir William Fergusson relates a case in which a similar error was avoided by an exploratory puncture, which should in no case be omitted.

They may be single or multiple; sometimes there appears to be a "cystic regeneration of the entire mucous membrane." Mr. Giraldès, who was the first writer on this subject, thinks they are due to "dilation of the glandular follicles of the mucous membrane, and that in such cases it will be necessary to open the antrum, so as to remove the entire mass, it being useless in such cases to pursue the customary plan of tapping the antrum."

Cysts of teeth are divided by Mr. Heath into two classes: "First, cysts connected with the roots of fully developed teeth; and, secondly, cysts connected with imperfectly developed teeth—to which the term 'Dentigerous Cysts' has been applied in modern times." They occur indifferently in either jaw; in the upper, however, are sometimes complicated with collections of fluid in the antrum, which they have secondarily affected. When of very small size they give but little trouble, and are frequently found attached to the roots of teeth after extraction, where their existence had not before been suspected. They seem to occur most frequently in connection with the incisor teeth, and

sometimes attain a very large size, even when not communicating with the antrum. They are commonly associated with the disease of the root about which they are formed, whether as cause or effect it is difficult to determine, the majority of observers holding the latter opinion. Mr. Paget relates a case in which the cyst contained as much as an ounce of fluid, and was received in a deep depression in the alveolar border of the jaw. And Delpech reports one containing so much as three ounces, without connection with the antrum. They consist essentially of a serous bag growing from the dental periosteum at the extremity of the root, filled with a clear or yellowish fluid with bright shining particles of cholesterin floating about in it. According to Mr. Tomes the morbid process is probably identical with that resulting in the formation of alveolar abscess, but, being less acute, a serous cyst is formed instead of a suppurating one.

FIG. 133.—CYSTS CONNECTED WITH ROOTS OF TEETH.

Mr. Heath remarks that "large cysts produce more or less absorption of the outer wall of the maxilla, and are very common consequences of diseased teeth, but seem to give surprisingly little inconvenience to the patients, even when of large size and producing considerable deformity of the face. They are commonly confounded with cystic distention of the antrum."

Mr. Heath says "the clinical history of cysts connected with the teeth is that of painless expansion of the alveolus, more frequently of the upper jaw, with crackling of the bone on pressure and ultimate absorption of the bony wall. The cyst then presents a bluish appearance through the distended mucous membrane, and if large, gives distinct evidence of fluctuation." When an incision is made into the cyst a dark-colored, clear fluid escapes, but when inflammation is present the contents become purulent.

The treatment of such cysts consists in cutting away the thin outer wall, so that the cavity may granulate up.

Dentigerous cysts occur in connection with teeth, most commonly permanent teeth, in which the process of evolution has been arrested, and is due, Mr. Tomes thinks, to the accumulation of fluid between the enamel and soft outer tissue at the time when the enamel is completed, which fluid is usually discharged when the tooth is erupted; but when the tooth remains within the jaw this discharge cannot take

place, and it continues to increase in quantity until a cyst is established. We are thus enabled to account for the presence of cysts in those cases in which neither the tooth nor adjacent bone presents any appearance of disease. In illustration of this theory, Mr. Tomes relates a case in which, "instead of having the two fangs common to second molars of the lower jaw, the implanted portion of the tooth was dilated into one large concavity, in which was placed the crown of a second tooth, perfectly invested with well-developed enamel, and with the masticating surface directed toward the jaw. The two teeth appear to be united by dentine at one point, and to have one common pulp-cavity. . . . . I consider that in the case cited fluid collected between the enamel of the inverted tooth and the remains of the

FIG. 134.—DENTIGEROUS CYST OF LOWER JAW. *b.* Showing position of tooth.

enamel organ, situated within the socket of the second molar. As the cyst enlarged, the contiguous bone was absorbed to make room for it, and new tissue was concurrently developed on the outer walls of the socket till at last a large cup of bone was formed." ("Dental Surgery.")

When cysts of this kind occur in the lower jaw they present more obvious deformity. Sometimes the cyst undergoes calcification, and is exceedingly difficult to diagnose from a solid tumor.

Mr. Heath remarks that "the diagnosis of dentigerous cysts from other cysts is exceedingly difficult until they are opened, as, indeed, is the recognition of any form of cyst. A careful examination of the mouth may reveal the absence of a permanent tooth, or may show a temporary tooth occupying a permanent position. On the other hand,

however, it must be remembered that teeth may be wanting without being connected with any disease."

Many errors of diagnosis, leading to operations for the removal of supposed tumors, have been made by able and distinguished surgeons, who have had the courage and candor to confess their mistakes, among whom may be mentioned Gensoul, Syme, Feavu, and Lisfranc. The two latter gentlemen each removed half the jaw. It is only when the osseous walls have become so wasted as to give under pressure a parchment-like crackling that the diagnosis may be made with any approach to certainty. In every case an exploratory puncture should be insisted on before proceeding to operate. The existence of a cyst determined, and communication with the antrum suspected, the first molar tooth should be removed and the wall of the antrum be perforated through the socket, and if a supernumerary tooth is found in the cavity it should, of course, be removed. In many cases it is necessary to remove the front wall of the antrum and stuff the cavity with lint, thus inducing granulations, before a cure

FIG. 135.—INVERTED CROWNS OF TEETH BETWEEN EXPANDED ROOTS OF OTHER TEETH, CAUSING DENTIGEROUS CYSIS.

can be effected. This can generally be effected without incision of the integument. When feasible, the plate of bone removed should be left attached to the periosteum and be replaced after removal of the cyst.

Cysts in the lower jaw present some peculiarities which make a second description necessary. They may occur in connection with fully developed teeth, or without any direct connection with the teeth. They may be multilocular, and in rare instances may contain one within another. Mr. Coote reports a case in an infant of six months —which resulted in death from exhaustion occasioned by continued discharge after an operation—in which, covered by a thin shell of bone, a perfect nest of cysts connected with the antrum have been shown to arise in the glandular structure of its lining membrane, but in the lower jaw we have no such membrane. Instead thereof we have two layers of laminated bone enclosing a cancellated structure lined by the endosteum alone. Mr. Heath is of opinion that it is in these calculi the disease is developed, "A cancellus expanding and producing gradual absorption and obliteration of its neighbors

until a cyst of considerable size is produced." The causation of cystic formations in the lower jaw is very obscure, though they are probably associated in some way with the irritation from adjacent roots. They may continue to reproduce themselves from time to time, until the cancellated tissue is entirely destroyed.

Cysts in connection with undeveloped teeth—dentigerous cysts—which are common to both jaws, may suppurate and form abscesses. They generally occur, in the case of unerupted teeth, from some irritation, and are more common to permanent than to deciduous teeth. Inversion of the tooth also appears to be a cause of these cysts.

Mr. Heath remarks that "when dentigerous cysts occur in the lower jaw they form more isolated and prominent tumors than in the case of the upper jaw, and in some cases the projecting bony wall has been removed."

FIG. 136. FIG. 137.
DENTIGEROUS CYST DUE TO NON-DEVELOPMENT OF CANINE TOOTH.

The treatment of dentigerous cysts consists in a free incision and the removal of the unerupted tooth, as a simple puncture will not answer. The front wall of the cyst should be removed, and the cavity filled with lint, "so as to induce granulation and gradual obliteration." This may be accomplished in the majority of cases without any incision of the integuments. After the removal of a portion of the cyst wall, in the case of dentigerous cysts of the lower jaw, the plates should be pressed together as much as possible; and the same may be accomplished in the case of the upper jaw by the pressure of pads and bandages. Mr. Heath directs that the cyst should always be reached by dividing the mucous membrane within the mouth, and without incising the cheek; but, if necessary, a single line of incision only should be made, so that as little after-deformity as possible may be produced.

Unilocular cysts are to be treated simply by extracting adjacent teeth, and, after evacuating the contents, when the walls are thin, crushing them in so as to diminish the size of the cavity. According to Mr. Eve multilocular cysts, so far from having a dental origin, are produced by an ingrowth of the epithelium of the gum. They may result from injury, the irritation of decayed teeth, or long-continued inflammation. They are of slow growth, and present very little tendency to implicate surrounding parts. Multilocular cysts are found in the lower jaw, consisting of cells varying in size from that of a pea to others occupying the entire thickness of the bone.

Multilocular cysts may be treated according to the plan of Mr. Butcher, which consists in dividing the mucous membrane over the cyst freely, and then with a gouge and the bone-forceps removing the expanded external plate of the bone, with the contents and lining membrane of the cyst, interfering with the teeth as little as possible and avoiding the facial artery. Dr. Mason Warren recommends a more conservative practice than that of Mr. Butcher. His treatment consists in the puncture of the sac within the mouth, and at the same time obliterating its cavity by crushing ; then to keep up, by injections, etc., a sufficient degree of irritation to favor the deposition of new bone.

CHAPTER IX.

CALCIC DEPOSITS ON THE TEETH.

SALIVARY CALCULUS.

The color, consistence, and quantity of salivary calculus, or tartar, as it is most commonly called, vary in different temperaments, and upon all of them the state of the general health exercises considerable influence. The characteristics of this substance, therefore, furnish diagnoses important both to the physician and dentist. Their indications are, in many cases, less equivocal than the appearances of any other part of the mouth ; but, like those of the gums, should not, perhaps, be alone relied upon. It is necessary to interrogate every part from which information can be derived concerning the pathological condition of the several organs of the body.

Salivary calculus is composed of earthy salts and animal matter. Phosphate of lime and fibrin, or cartilage, are its principal ingredients ; a small quantity of animal fat, however, enters into its composition, and the relative proportions of its constituents vary accordingly

as it is hard or soft, or as the temperament of the individual from whose mouth it is taken is favorable or unfavorable to health. Hence it is that the analyses that have been made of it by different chemists differ. No two give the same result.

The black, dry calculus deposited around the necks of the teeth of such only as have good constitutions is never in large quantities; it is dissolved in muriatic acid with difficulty, while the dry, light-brown calculus found upon the teeth of bilious persons dissolves more readily in it; but the soft, white calculus found upon the teeth of individuals of neuro-lymphatic temperaments is scarcely at all soluble in the acids, but is readily dissolved in the alkalies.

All persons are subject to deposits of salivary calculus, but not alike; it collects on the teeth of some in larger quantities than on those of others, and its chemical and physical characteristics are exceedingly variable. It is sometimes almost wholly composed of calcareous ingredients; at other times these constitute but about one-half, or little more than one-half, of its substance, the remainder being made up of animal matter. Nor is its color more uniform. Sometimes it is black, at other times it is of a dark, pale, or yellowish brown, and in some instances it is nearly white. It also differs in density. In the mouths of some it has a solidity of texture nearly equal to that of the teeth themselves; in others it is so soft that it can be scraped from the teeth with the thumb- or finger-nail. The black kind is the hardest, the white the softest, and its density is increased or diminished as it approaches the one or the other of these colors.

Salivary calculus collects in very small quantities on the teeth of persons possessed of the most perfect constitutions, and even on these it is seldom found except on the inner surfaces of the lower incisors next the gums. It is then black, or of a dark brown, very dry, and almost as hard as the teeth, to which it adheres with great tenacity.

It rarely happens that any unpleasant effects are produced by the presence of this form of calculus upon the teeth. The general health is never affected by it, and the only local injury that results from it is slight turgidity of the edge of the gums in immediate contact with it.

The indications, therefore, of this description of calculus are favorable, both with regard to the teeth, gums, and organism generally. The teeth upon which it is found are of an excellent quality and rarely affected by caries. They have the characteristics represented as belonging to the best kind, and teeth of this description are only found among persons having good innate constitutions.

There is another form of black calculus differing from this in many particulars. It is found in the mouths of those having good constitutions, but whose physical powers have been enervated by privation or

disease, or intemperance and debauchery, and most frequently by the last named. It is found in large quantities on the teeth opposite the mouths of the salivary ducts; it is exceedingly hard, and agglutinated so firmly to the organs that it is removed with great difficulty; it is very black, has a rough and uneven surface, and is covered with a glairy, viscid, and almost insufferably offensive mucus.

The presence of this kind of salivary calculus is attended with very hurtful consequences, not only to the gums, alveolar processes, and teeth, but also to the general health. It causes the gums to inflame, swell, suppurate, and recede from the teeth, the alveoli to waste, and the teeth to loosen and frequently to drop out. The secretions of the mouth are also vitiated by it and rendered unfit to be taken into the stomach. Hence, as long as it is permitted to remain on the teeth, neither the skill of the physician nor the best regulated regimen, though they may afford partial and temporary relief, will fully restore to the system its healthy functions.

As this form of calculus is seldom if ever met with except in constitutions fairly excellent, the teeth on which it is deposited are generally sound, but they are often caused, by the disease which is produced in the gums and alveoli, to loosen and drop out.

The dark-brown calculus is not so hard as either of the descriptions of black. It sometimes collects in tolerably large quantities on the lower front teeth and on the first and second superior molars; it is also often found on all the teeth, though not in as great abundance as on these. It does not adhere with as much tenacity as either of the preceding kinds, and can be more easily detached from them. It exhales a more fetid odor than the first variety, but is less offensive than the second.

The persons most subject to this kind of calculus are of mixed temperaments, the sanguineous, however, always predominating. They may be denominated sanguineo-serous and bilious. Their physical organization, though not the strongest and most perfect, may, nevertheless, be considered very good. But, being more susceptible to morbid impressions, their general health is less uniform and more liable to impairment than those possessed of the most perfect constitutions.

The effects arising from the accumulations of this description of salivary calculus, both local and constitutional, are less hurtful than the variety last noticed; but, like that, it causes the gums to inflame, swell, suppurate, and to retire from and expose the necks of the teeth, the alveoli to waste, the teeth to loosen and sometimes to drop out. It also gives rise to a vitiated condition of the fluids of the mouth.

Salivary calculus of a light or pale yellowish-brown color is of a much softer consistence than the darker varieties, and is seldom found

upon the teeth, except of persons of bilious temperament, or those in whom this predominates. It has a rough and, for the most part, a dry surface; it is found in large quantities opposite the mouths of the salivary ducts, and sometimes every tooth in the mouth is completely imbedded in it. It contains less of the earthy salts and more of the animal matter than any of the foregoing descriptions, and, from the quantity of vitiated mucus in and adhering to it, has an exceedingly offensive smell. It is sometimes, though not always, so soft that it may be crumbled between the thumb and finger.

Inflammation, turgescence, and suppuration of the gums, inflammation of the alveolo-dental periosteum, the destruction of the sockets and loss of the teeth, and an altered condition of the fluids of the mouth are among the local effects produced by the long-continued presence of large collections of this variety of tartar. The constitutional effects are not much less pernicious. Indigestion and general derangement of all the assimilative functions are among the most common. When the deposit is not large, inflammation and sponginess of such parts of the gums as are in immediate contact with it, and fetid breath, are the principal of the unpleasant effects produced by it.

White calculus rarely collects in very large quantities, and though most abundant on the outer surfaces of the first and second superior molars and the inner surfaces of the lower incisors, it is nevertheless frequently found on all the teeth. Its calcareous ingredients are less abundant than those of any of the preceding descriptions. Fibrin, animal fat, and mucus constitute by far the larger portion of its substance. It is very soft, seldom exceeding in consistence common cheese-curd, to which in appearance it bears considerable resemblance. Although it exerts but little mechanical irritation upon the gums, it keeps up a constant morbid action in them. Its effects, however, upon the teeth are far more deleterious than any other description of calculus. It causes rapid decay of the organs, and the fluids of the mouth are also vitiated by it.

It is only upon the teeth of persons of mucous habit, or those who have suffered from diseases of the mucous membranes, or those in whom these tissues have been more or less involved, that this kind of calculus accumulates.

Salivary calculus sometimes accumulates in very large quantities, giving to the mouth a most disagreeable and repulsive aspect, and imparting to the breath, not unfrequently, an almost insufferably offensive odor. Fig. 138 represents a set of teeth incrusted with it, and Fig. 139 a single tooth, presented to the author by Dr. W. Allen, of Massachusetts, with the largest accumulation of this substance he has ever seen in one mass. Its longest diameter is an inch and an eighth,

its shortest seven-eighths, and its thickest five-eighths of an inch. Imbedded in its substance is the entire crown and neck of a lower dens sapientiæ, which was removed with it. It is of a light-brown color, and weighs two drams and seventeen grains.

The late Prof. Austen described an interesting case where every tooth, above and below, had been loosened by alveolar absorption caused by this deposit; no tooth having more than an eighth of an inch depth of socket, and some of them held only by an exceedingly tough attachment to the gum and periosteum. The calculus upon the lower incisors was equal to five times the size of the teeth, most of it being on the inside, and three-quarters of an inch thick at the base.

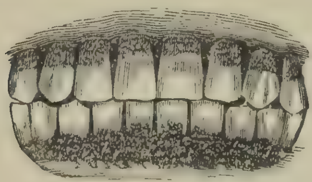


FIG. 138.

FIG. 139.

A singular peculiarity in this case was the excessive pain of extraction. Small as was the attachment, it was uncommonly firm, and the patient, a working-man, was laid up with nervous prostration for two weeks after the operation.

CHEMICAL CONSTITUENTS OF SALIVARY CALCULUS.

Salivary calculus is composed of phosphate of lime and animal matter, combined in various proportions, accordingly as it is hard or soft; consequently no two analyses will yield the same result.

Schehevetskey gives the following analysis. He found one hundred parts to contain :—

Water and organic matter,	22.07
Magnesium phosphate,	1.07
Calcium phosphate,	67.18
Calcium carbonate,	8.13
Calcium fluorid,	1.55
	100.00

Dr. Stevenson furnishes the following :—

	Friable soft calculus from molars.	*Hard calculus from lower incisors.*
Water and organic matter,	21.48	17.51
Phosphate of magnesia,	1.31	1.31
Phosphate of calcium, with a little carbonate and a trace of fluorid,	77.21	81.18
	100.00	100.00

Hard, dry salivary calculus contains more earthy and less animal matter than the soft, humid calculus.

Chemical analysis reveals a large proportion of mucus, as is shown by the following table of Vaquelin and Langier :—

Phosphate of lime and a little magnesia,	66
Carbonate of lime,	9
Salivary mucus (including ptyalin),	13
Animal matter soluble in hydrochloric acid,	5
Water and loss,	7
	100

An analysis of saliva reveals water, ptyalin, fat, chlorid of sodium, chlorid of potassium, phosphate of lime, and sulphocyanid of potassium.

The infusoria of salivary calculus, according to M. Mandl, have their origin in the vitiated mucus which is always mixed with it.

Scherer detected with a microscope infusoria in large numbers in the saliva of a girl laboring under a scorbutic affection of the mouth; but the author is inclined to believe that they had their origin in the mucous secretions of this cavity, which are always mixed with the former fluid. They are more or less numerous, as the calculus is hard or soft, or in proportion to the quantity of mucus that enters into its composition.*

ORIGIN AND DEPOSITION OF SALIVARY CALCULUS.

There formerly existed much diversity of opinion as to the source whence salivary calculus is derived, but it is now generally conceded that this deleterious concretion is a deposit chiefly from the saliva, with an admixture of mucus, as the analyses of both these secretions reveal the necessary materials in sufficient quantity to form it. Bidder and Schmidt make the phosphates and carbonates amount to very nearly one per cent. in the saliva. All that is necessary, therefore, is that the surfaces of the teeth should have a sufficient affinity for the substance in question to cause a nucleus, which, when once formed, the secretion continues until serious secondary effects are liable to result.

In most varieties of salivary calculus there is a notable superabundance of the phosphates and carbonates, while in others there is nearly forty per cent. of purely animal matter. Hence the difference in action upon them by acids and alkalies. Of the animal matter entering into the composition of salivary calculus, fibrin, animal fat, and mucus are in the largest proportion.

* Dr. Dwinelle gives a minute description of their appearance in the first number of the fifth volume of the *American Journal of Dental Science.*

Of the existence of the elements of the composition of calculus in the saliva there can be no question. Chemical analyses of this fluid, direct from the glands, place all doubt upon the subject at rest. Thus it is seen that the chief earthy constituents which enter into the formation of this substance are contained in the saliva. It may also exist in solution in the mucous fluid of the mouth.

That the deposition of calculus may take place on one side of the mouth without a similar deposit on the opposite side furnishes no evidence in support of the doctrine which has been advanced, that it is an exhalation from the capillaries of the mucous membrane of the gums. The mastication of food is, with most persons, performed more on one side of the mouth than on the other; that this function prevents, in a great degree, the accumulation of calculus on the organs immediately concerned is a fact with which every dentist must be familiar. Hence its frequent collection on the teeth of one side and not on those of the other. And that it is ascribable to this circumstance is susceptible of positive proof. If, on the removal of the calculus from the teeth of a person in whose mouth it has collected only on those of one side, mastication be afterward altogether performed on this side, it will not reaccumulate on them; and if requisite attention to the cleanliness of the teeth on the other side be not observed, it will soon collect there, although these teeth had before remained free from it.

Again, it often happens that disease of a severe character is excited in the gums by the use of mercurial medicines and other causes, and yet but a small quantity of calculus collects on the teeth; but that any condition of the general system, or of the mouth, tending to make the fluids of this cavity more viscid, promotes its formation is undeniable. There are, however, some temperaments much more favorable to its production than others; and it is a well-established fact that the mucous membrane of those in whose mouths it accumulates in largest quantity is the most irritable, and the buccal most viscid. Again, if it were deposited by the mucous fluids of the mouth, it would collect in largest quantities on those teeth which are less abundantly bathed in the saliva; as, for example, the anterior surfaces of the upper incisors and cuspids, while those opposite to the mouths of the ducts which discharge this fluid into the mouth would be less liable to deposits of calculus than any of the other teeth; whereas the contrary is found to be the case.

The conclusion, therefore, is, that this earthy matter is chiefly a salivary deposit and takes place in the following manner: It is precipitated from the saliva, as this fluid enters the mouth—especially when the secretion is sluggish—upon the surfaces of the teeth opposite the openings into the ducts from which it is poured. To these its

particles become agglutinated by the mucus always found, in greater or less quantity, upon them. Particle after particle is deposited, until it sometimes accumulates in such quantities that nearly all the teeth are almost entirely incrusted with it.

As regards the points of deposit of salivary calculus, the greatest quantities are found opposite the mouths of the ducts of the salivary glands, upon the lingual surfaces of the inferior incisors, cuspidati and bicuspids, and the buccal surfaces of the superior molars. The necks of the teeth, about the free margins of the gums, afford favorable points for its collection, as here the saliva is longer retained and its calcareous ingredients precipitated than upon more exposed parts. It first collects about the necks of the teeth in semicircular or crescent-like lines close to the enamel, under the edge of the gums, and a nucleus being once formed it rapidly encroaches upon the crown, where it is deposited more abundantly. Certain varieties of salivary calculus adhere to the necks of the teeth with great tenacity, and often progress as far as the apex of the root, until the teeth are deprived of their support and their roots left denuded and exposed. Salivary calculus is never deposited on the flesh, but only upon such substances as represent the teeth or form nuclei, as artificial teeth, for example. It is sometimes deposited in the ducts, which may be owing to a sluggish condition of the saliva, in a form known as ranula, and has been removed in a mass as large as a hazelnut.

M. Robert presented to the Anatomical Society of Paris a hog's bristle, which had been forced into the duct of Wharton, densely covered with a thick salivary concretion.

From the fact that salivary calculus is often found upon parts where the saliva cannot be retained for any length of time, it is evident that it is sometimes precipitated as soon as this fluid enters the mouth.

EFFECTS OF SALIVARY CALCULUS UPON THE TEETH, GUMS, AND ALVEOLAR PROCESSES.

Although salivary calculus does not directly act injuriously upon the substance of the teeth, but, on the contrary, preserves the part it covers from the action of chemical agents, yet the effects of the presence of this substance are always pernicious, though sometimes more so than at others. An altered condition of the fluids of the mouth, diseased gums, and not unfrequently the gradual destruction of the alveolar processes, and the loosening and loss of the teeth, are among the consequences that result from it. But besides these, other effects are occasionally produced, among which may be enumerated tumors and spongy excrescences of the gums of various kinds, necrosis and exfoliation of the alveolar processes and of portions of the maxillary

bones, hemorrhage of the gums, anorexia, derangement of the whole digestive apparatus, and foul breath, catarrh, cough, diarrhea, diseases of various kinds in the maxillary antra and nose, pain in the ear, headache, melancholy, hypochondriasis, etc. So irritating is its presence that wherever it comes in contact with the gums and alveoli it causes their absorption, which in some cases may, at first, be attended with little or no inconvenience; while in others considerable inflammation, ending in suppuration of the gums, may result, extending to the mucous membrane of the mouth. Periostitis and necrosis of the alveolar processes are also results of the irritating action of this substance. The character of the effects, however, both local and constitutional, depends upon the quantity and consistence of the calculus, and upon the temperament of the individual as well as the state of the general health; the two former of these are determined by the two latter and by the attention paid to the cleanliness of the teeth. If this last be properly attended to, salivary calculus, no matter how great the constitutional tendency to its formation, will not collect in large quantity upon the teeth. The importance, therefore, of its constant observance cannot be too strongly impressed upon the patient, especially in those in whom there exists a great tendency to its deposition.

The teeth and their contiguous parts suffer more from accumulations of this substance than from almost any other cause. Caries is not much more destructive to them. When permitted to accumulate for any great length of time the gums become so morbidly sensitive that a tooth-brush cannot be used without causing pain; consequently, the cleanliness of the mouth is not attempted, and thus, no means being taken to prevent its formation, it accumulates with increased rapidity, until the teeth, one after another, fall in quick succession victims to its desolating ravages.

It sometimes not only undermines the constitution by occasioning discharges of fetid matter from the gums and corrupting the fluids of the mouth, but it also renders the breath exceedingly unpleasant and offensive. So nauseating and disagreeable is the odor which some descriptions of calculus exhale that the atmosphere of a whole room is contaminated by it in a few minutes.

MANNER OF REMOVING SALIVARY CALCULUS.

This is an operation of great importance to the health of the gums, alveolar processes, and teeth. But from a misconception of its nature, rather than from fear of pain, many are much opposed to it; and, notwithstanding the universal admiration in which clean and white teeth are held, they will suffer the beauty of these organs to be destroyed

rather than submit to its performance. There are some, indeed, who, though scrupulously particular in everything that regards dress, seem, nevertheless, to consider cleanliness of the mouth as unworthy of notice.

For the removal of calculus from the teeth a variety of instruments are necessary, which should be so constructed that they may be easily applied to every part of every tooth. Those in common use among dental practitioners are so very similar in their shape and so well known that we do not deem it necessary to point out the minute differences of construction, or even to give a general description of the instruments themselves. The instruments should be light, made with ivory, ebony, or cocoa handles, and tapering from a little above the ferule both ways; and the points of the instruments should be delicately shaped, so as readily to pass below the free edge of the gum. The success of the operation depends much upon the careful removal of every particle of deposit, for which a heavy, clumsy, or large-bladed instrument is wholly unsuited. If any particles of calculus be suffered to remain, they will irritate the gums and serve as nuclei for immediate re-accumulations.

Drs. F. Abbott's and How's sets of scalers, represented in the following figures, are well adapted for removing salivary calculus from all parts of the teeth.

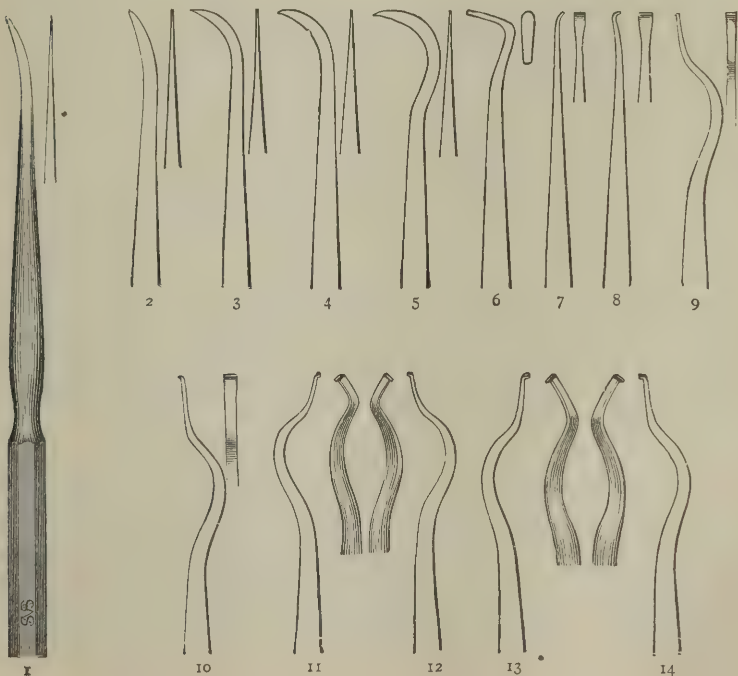


Fig. 140.

The adhesion of salivary calculus to the teeth is sometimes so great that considerable force is required for its removal, even when the sharpest and best-tempered instruments are employed, but ordinarily it may be removed with ease. Considerable tact, however, is necessary to perform the operation in a skillful manner; more than most persons, from its apparent simplicity, imagine. This skill can only

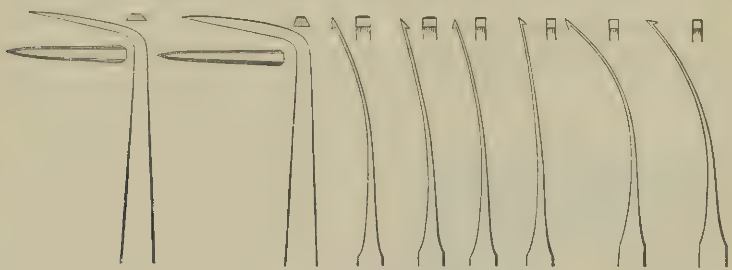


FIG. 141.

be acquired by practice. Calculus may be taken from the outer and inner surfaces of the teeth without much difficulty, but the removal of it from between them is more troublesome, and can only be effected by means of very thin, sharp-pointed instruments. Many, however, prefer scaling instruments with slender points, such as are represented by Fig. 141, which are used with a pushing motion in a direction from

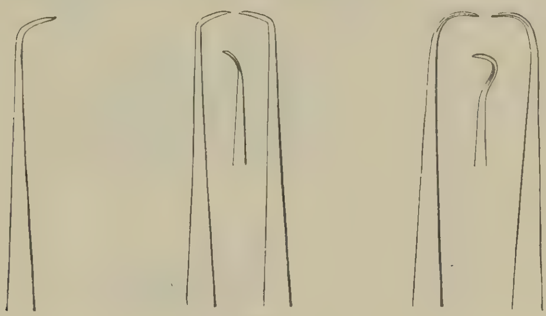


FIG. 142.

the hand, instead of toward the hand. Fig. 142 represents a set of five scalers suggested by Dr. How.

In removing this substance from the teeth the point or edge of the scaling instrument should be applied below the deposit, between it and the gum, and passed well under, until it comes in contact with the surface of the tooth, and the mass scaled off in the direction of the cutting edge or grinding surface.

Care is necessary that the edge of the instrument does not roughen the tooth substance, especially the dentine, beyond the enamel. After the removal of the greater part of the deposit, the instrument should be lightly passed over the surface, to detach any particles which may remain, especially upon the approximal surfaces. After the use of the scaling instruments finely pulverized pumice or silex should be applied on a piece of orange wood so shaped as to reach all parts on which the deposit has collected.

The wood-points of various forms, charged with finely-powdered pumice or silex and rotated by means of the dental engine, are very useful for removing the discoloration caused by salivary calculus and the dark mucous deposit, which often cause the teeth to present quite an unsightly appearance.

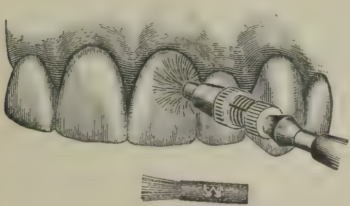


FIG. 143.

The small tooth-polishing brushes represented by Fig. 143, and the soft-rubber polishing cups suggested by Dr. J. B. Wood, Fig. 144, both operated by the dental engine, will cleanse teeth from remains of calculus after use of scalers and from discoloration, even under the free borders of the gums. The cervical margins of fillings may also be polished by the small brushes and cups.

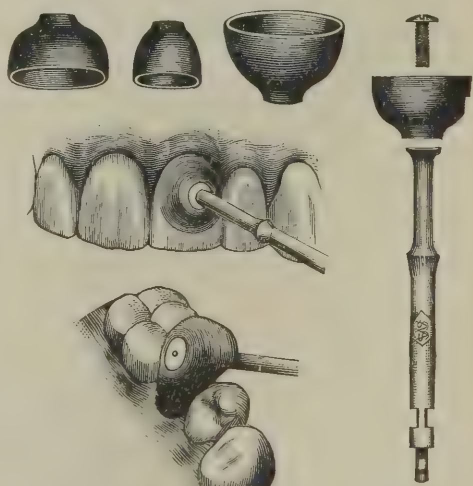


FIG. 144.

Where the surface of the enamel or dentine is found to be rough and without the natural polish, after the use of the pumice or silex, Arkansas stone and the burnisher may be applied with advantage, and a finely polished surface obtained.

Several sittings are sometimes necessary for the completion of the operation, especially when the calculus has accumulated in very large quantities. In all cases of this sort it should be first removed from between the edges of the gums and the necks of the teeth. During

the intervals between the several operations the mouth should be gargled several times a day with some cooling and astringent wash; but on this subject more particular directions will be given in another chapter.

During the removal of calculus from the teeth the gums often bleed very freely; and when much swollen and spongy it may be well to promote it by holding tepid water in the mouth. When the lower incisors are loose, as is often the case, the operation should be proceeded with very cautiously, and the teeth supported by the fingers of the left hand holding the jaw, especially when the calculus is very hard and adheres with great tenacity.

Chemical agents are sometimes employed for the removal of salivary calculus, especially such of the vegetable and mineral acids as are supposed to have less affinity for the lime of the teeth than the phosphoric acid with which it is combined; but it is scarcely necessary to say that any acid capable of dissolving tartar will act upon these organs. The use of all such agents should be most scrupulously avoided. Nearly all acids, both mineral and vegetable, as has been shown in another part of this work, are prejudicial to the teeth. Their careless administration by physicians is a fruitful source of injury to the teeth. And they certainly should form no part of any dentifrice, or be in any way used for the removal of stains of any kind from the teeth.

Pyrozone, in three or five per cent. solutions, is recommended for its softening action upon any incrustations about the teeth, thus rendering their removal easy, and causing no injury to the tooth structure or on myxomatous tissues. Care should be taken, however, that the five per cent. solution does not come in contact with the gum, as its effect is more or less painful for a short time.

SANGUINARY OR SERUMAL CALCULUS.

By this title Dr. L. C. Ingersoll designates a structureless calcareous deposit found at the apex of the root of a tooth, or sometimes extending in a line of granules along the root from the apex to the neck of the tooth, or again encircling the root immediately beneath the free margin of the gum. Being of sanguinary origin, it is found only where the serum of the blood is present, which, being decomposed, gives up its lime salts and affords material for the deposit, which is stained with the hematin of the blood. This form of calculus is derived from the serum that exudes from the diseased tissue, and its superior hardness is due to its being more purely mineral than salivary calculus, and it is generally of a black or dark-green color. Sanguinary calculus is deposited upon the roots of the teeth,

and not upon their crowns, as is the case with salivary calculus, being often found upon the very apex of the roots. It also differs in another respect from salivary calculus; the sanguinary, resulting from the disorganization of blood and ulceration of tissues, is in the form of dark, hard granulations approaching crystallization. The root of the affected tooth is denuded of its cementum, and the granular deposit so closely adheres that its removal is quite difficult. Sometimes it is found immediately beneath the margin of the gum, in the form of a dark, hard, rough ring, which may occasionally be visible through the gum in the form of a dark circle. A viscid, serous fluid may exude from about the neck of the tooth under slight pressure, the result of the ulceration which gives rise to the deposit. This fluid is not of the same nature as the pus from an abscess, being watery and nearly odorless, and composed, in a great part, of the serum of the blood. While salivary calculus causes inflammation, sanguinary calculus is a result of inflammatory action, and is found upon teeth affected with ulceration. The method of removing sanguinary calculus is referred to in the treatment of alveolar pyorrhea.

MUCOUS DEPOSIT ON THE TEETH.

While persons of all ages are subject to deposits of salivary calculus, there is a mucous deposit to which the teeth of children are especially liable, in the form of a brown or a green stain, which has been erroneously called green tartar. This deposit is generally found upon the labial surfaces of the front teeth, more especially upon those of the upper jaw, and varies in color from a light brown to a dark green. From its not collecting upon the posterior teeth and upon the lingual surfaces of the inferior front teeth opposite the mouths of the ducts leading from the salivary glands, there is every reason to conclude that this deposit is not precipitated by the saliva, and hence is altogether different in its origin from salivary calculus. It is generally considered to be a deposit from the mucus, when this secretion is in a more acid condition than is natural. From its effects upon the teeth when it is allowed to remain on them for a considerable time, and also from the fact that it is most abundant when the mucus is secreted in large quantities and of a decidedly acid reaction, there is little doubt as to its origin from this secretion.

That it is not deposited on all parts of the teeth is no reason for doubting the correctness of this theory, when we consider that the parts upon which it is found are those protected from the friction of food and the movements of the tongue and the flow of the saliva.

This form of discoloration of the enamel is indicative of an irritable condition of the mucous membranes and viscidity of the fluids

of the mouth. Sour eructations, vomitings, diarrhea, and dysentery are not infrequent with those whose teeth are thus affected. While the presence of this green stain on lately erupted teeth is almost a certain indication of softened enamel, this is not the case when it is deposited on adult and very dense teeth. In the latter case it does not appear to be a precipitate from the mucus, as salivary calculus is from the saliva, but is rather a growth of fungi upon the surface, and it is yet an open question whether it develops its own acid, as in the case of the "sprosspilz" lately described by Dr. Miller, or whether it retains the neutral secretions to the acidulated stage.

According to Wedl, it may "readily be demonstrated that the deposit is a green, greenish-yellow, uniformly minutely granular mass which is morphologically identical with the matrix of the leptothrix."

In regard to the effects of this mucous deposit upon the teeth, while salivary calculus tends to preserve the portion of tooth-substance on which it is precipitated, this green stain so erodes the enamel that decay advances in the part which it covers, more or less rapidly, according to the quality of the teeth and the length of time it is allowed to remain. The removal of this mucous deposit requires more skillful manipulation than that of salivary calculus, on account of its being a thin film entering into the substance of the enamel, rendering it difficult to detach without injury to the tooth substance; whereas salivary calculus is deposited in such quantities as to leave thick incrustations, which are readily scaled off from an uninjured surface. Where the erosion caused by this mucous deposit is but slight, it may be removed by Arkansas or Superior stones, or by finely powdered silex or pumice stone and water applied on a stick of hard, fine-grained wood, such as orange wood or hickory; the point of the piece of wood being so formed as to adapt it well to the surface on which it is to be used. The wood-points or small brushes, or soft rubber cups, charged with either of the powders referred to, and rotated by means of the dental engine, will prove very serviceable for such an operation. After all the discoloration is removed by the means just referred to, the surface should be well burnished with a steel burnisher and a solution of pure Castile or white Windsor soap. Pyrozone in five per cent. solution is also useful in removing this green stain, care being taken that it does not come in contact with the gum tissue. When, however, the effects of this mucous deposit are more serious, the enamel not only being discolored but deeply eroded, it is necessary to make use of the corundum point, rotated by means of the dental engine, the enamel chisel, or file, to remove the injured surface. The enamel chisel is to be preferred to the file in all cases where it is applicable; and the plain surface thus obtained should be polished with fine silex or pumice stone, Arkansas or

Superior stones, and the burnisher. Care is necessary in the use of the enamel chisel, to avoid wounding the neighboring soft tissues. To prevent the possibility of such an accident and to enable the operator to have control over his instrument, the chisel should be held firmly with the hand in such a manner as to allow the thumb to rest on an adjoining tooth. When the dentine is very sensitive, as is frequently the case, a proper agent for allaying the sensitiveness may be applied from time to time to the surface, as the operation of cutting it away proceeds. (See "Treatment of Sensitive Dentine.")

CHAPTER X.

NECROSIS AND EXFOLIATION OF THE ALVEOLAR PROCESSES.

THE alveolar processes, as well as other osseous structures, are liable to necrosis or loss of vitality. When their connection with the peri-osteum—the source from whence they derive their nourishment and vitality—is destroyed, death follows as a necessary consequence. The loss of vitality may be confined to the socket of a single tooth, but more frequently it extends to several, and sometimes to the alveolar border, occasionally including a part or the whole of the jaw. It may occur in either jaw, but it is more liable to take place in the lower than in the upper. When confined to the alveoli the dead part is never wholly replaced with new bone, but examples are on record of the re-generation of a large portion of the lower jaw.

FIG. 145.—SECTION OF NECROSED LOWER JAW.

When one or more of the cavities of the teeth lose their vitality, nature exerts all her energies to separate the dead from the living bone; this process, technically termed *exfoliation,* is supposed by some to consist in a sort of suppurative inflammation, but there is reason to believe it is effected by the action of a corrosive fluid poured out from the fungous granulations of the living bone in immediate contact with the necrosed part. During the process of exfoliation a thin, acrid matter is discharged from one or more fistulous openings through the gums or from between them and the necks of the teeth; the gums, having lost their connection with

the necrosed bone, become soft and spongy, and assume a dark purple appearance, are preternaturally sensitive to the touch, and bleed from the most trifling injury.

The subject of a case worthy of notice was a lady of a cachectic habit, about thirty-five years of age. The necrosis resulted from inflammation of the peridental membrane, occasioned by irritation produced by the roots of four incisors upon which pivot teeth had been placed, which, however, had been removed some two or three weeks before the author saw the patient. At this time necrosis had extended not only to the sockets of these teeth, but also up to the nasal crest of the maxillary bone, and the process of exfoliation had already proceeded so far that he was enabled to remove the entire piece, the appearance of which is represented in Fig. 146. A few weeks after the removal of this piece he again saw the patient, and, on examination, found a large portion of the palatine plate of the bone in a necrosed state; but the process of separation had not yet proceeded far enough to enable him to remove it.

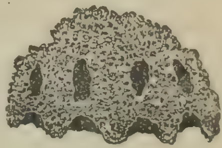


FIG. 146.

The accompanying engraving, made from a drawing furnished the author by Dr. Maynard, represents a case of necrosis and exfoliation of a portion of the outer wall of the alveolar ridge, and the consequent protrusion of the roots of the teeth on one side of the mouth.

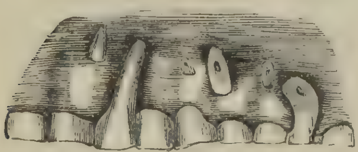


FIG. 147.

The alveolar process in relation with the superior central incisors appears to be more susceptible to necrosis than other portions, and this may be ascribed to such causes as diminished vitality occurring during conditions of depression and debility, the liability of such a prominent part to mechanical injury, and the effect of suppurative inflammation upon a portion of the process which possesses a less degree of restorative power than other portions better protected by muscular tissue.

Phosphor-Necrosis.—Necrosis of the bones of the jaws may also result from exposure to the fumes of phosphorus, as in the manufacture of matches, for example.

The disease, when due to such a cause, usually commences about a carious tooth, or in an alveolar cavity opened by the extraction of a tooth, and is sometimes complicated with affections of the lungs and air-passages.

In phosphor-necrosis there is a peculiar pasty appearance of the face, puffiness of the cheeks, and considerable pain and swelling in the

affected jaw. Instead of the separation of a sequestrum, the dead bone becomes incrusted with a pumice-stone-like material, which adheres very firmly to it. Abscesses form and discharge externally through the skin of the cheek, and leave fistulous openings for the escape of the matter.

Causes.—The immediate cause of necrosis is the death of the periosteum, occasioned by inflammation. The cause of this, as has already been shown, is, in a large majority of the cases, dental irritation. Necrosis of the alveolar process occurs very frequently while the system is under the influence of mercurial medicines, and during bilious and inflammatory fevers, and certain other constitutional diseases, as syphilis, smallpox, etc. It may also result from mechanical injuries and the devitalizing effect of such agents as arsenious acid and chlorid of zinc, when applied to destroy pulps of teeth, and so obtund the sensibility of dentine, etc., etc.

Treatment.—The treatment of cases of this kind consists in the removal of the sequestra, strict attention to cleanliness, and the free use of chlorinated washes. As soon as the dead portions of bone become separated from the living, and can be easily removed, they should be taken away with a pair of forceps. Should the removal of a considerable portion of the bone of the jaw be requisite, it is seldom necessary to interfere with the skin or make an external incision. The whole of the lower jaw can be removed in this manner by dividing it at the chin, and after separating all the attachments of the soft parts with the knife, drawing out each half at a time.

To correct the offensive odor and disagreeable taste occasioned by the constant discharge of fetid matter, washes of chlorid of sodium may be employed.

There is no remedy, perhaps, that gives more satisfaction in the treatment of necrosed alveolar process and carious bone, than dilute aromatic sulphuric acid, combined with a small quantity of tincture of capsicum, using alternately the antiseptic known as "listerine." Prior to the application of such agents, the diseased parts should be syringed with tepid water, and this cleansing process continued throughout the entire course of treatment. While cold water will coagulate pus and unhealthy secretions, which are irritating by their pressure, warm water will produce the opposite effect, and is a useful adjunct to the antiseptic remedies. The removal of teeth, in cases of necrosis of the alveolar process, should only be resorted to after mature consideration, for it frequently happens that the affection is confined to the labial walls, and if it is arrested new bone may be formed to such a degree as to give stability to the teeth in relation with the affected part.

Condy's fluid, or a solution of permanganate of potash, a weak solution of carbolic acid, or a solution of chlorinated soda, will answer as disinfectants and correct the fetor. The strength of the patient should be supported by stimulants and tonics, and good nourishment.

ABSORPTION OR GRADUAL DESTRUCTION OF THE ALVEOLAR PROCESSES.

This disease, to which the term "phagedenic pericementitis" has been applied, is a destruction of the walls of the alveolar cavities of the teeth, by a process of absorption which is always preceded by a corresponding loss of the peridental membrane, and which is usually the result of a chronic form of inflammation.

It is always accompanied by a slight increase of redness, tumefaction, and a shrinkage of the edges of the gums (ulatrophia); but the diseased action here is so inconsiderable as often to attract little attention. It is also attended by a slight discharge of purulent matter from between the margin of the gum and tooth; but the quantity is so small that it usually escapes observation. The peridental membrane participates also in the diseased action, but this is so often confined to the corresponding wall of the process which is absorbed away, that the tooth often remains quite firmly articulated, after the wasting of its socket has proceeded even so far as to expose more than half of the root. Indeed, the affection appears to be closely allied to chronic inflammation and tumefaction of the gums.

The progress of the disease is often so slow that ten, fifteen, or twenty years are required to affect very perceptibly the stability of the teeth in their cavities. The commencement of this destructive process is usually first observed around the cuspid teeth; sometimes it makes its appearance on the alveoli of the palatine roots of the first and second upper molars, and occasionally it goes on here for years before it affects the cavities of any of the other teeth.

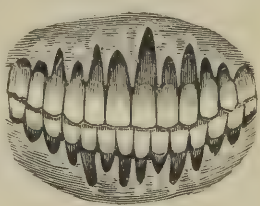


FIG. 148.

The teeth, after their roots have been partially exposed, become, as might naturally be supposed, more susceptible to impression from heat and cold, and more easily affected by acids or saccharine matters; but this is about the only manifest inconvenience experienced from the disease until the teeth begin to loosen in their cavities and are gradually displaced.

In Fig. 148 is represented a case in which the roots of the teeth have become considerably exposed by the gradual wasting of their

sockets—the destruction being, as is usual, greatest toward the median line.

Apparently the absorption of the bone occurs as a consequence of the inflammation of the peridental membrane.

Causes.—The cause of this peculiar affection has never been very satisfactorily explained. Some have supposed that, inasmuch as it occurs most frequently in persons of advanced age, it results from a decline of the vital powers of the body, independently of local causes; but, as it is often met with in middle-aged persons whose constitutional health is unimpaired, we doubt the correctness of the opinion. In all cases which have come under our observation, whether in middle-aged or very old persons, the teeth indicated an excellent innate constitution, whatever may have been the state of the general health at the time. In every instance these organs were possessed of great density, and it is evident that teeth endowed with the power of resisting to so late a period of life the action of the causes of decay, to which all teeth are more or less exposed, must be possessed of extreme hardness, and, necessarily, a corresponding low degree of vitality. In view of this fact we have been led to the opinion that the teeth themselves may act to some extent as the mechanical irritants to the more highly vitalized parts with which they are immediately connected, causing an increase of vascular action in the periosteum of the thin edges of the alveoli and margin of the gums. This abnormal condition is attended by a slight secretion of purulent matter observed between the edges of the gums and teeth. It is to the corrosive action of this purulent matter that the gradual destruction of the alveoli has by some been attributed; but it is more probably a result of the obscure disease than its cause.

This affection has been ascribed to the presence of salivary and sanguinary calculus, the use of charcoal powder as a dentifrice, and the application of a very stiff brush for cleaning the teeth; but when caused by these two latter agents the absorption does not progress to such a degree as when it is owing to a want of congeniality between the tooth and the more highly vitalized structure surrounding its root, or the other causes before referred to.

A later theory as to the cause of this affection has been advanced by Dr. Arkoevy, who believes that it is caused by a certain fungous formation found in close connection with the wasting of the alveoli and the gingival margin, as well as the subsequent loosening of the teeth; and that it is quite different from leptothrix buccalis, although it is in developmental relation with it.

Dr. G. V. Black also states that it is probable that the disease is caused and maintained by the presence of some peculiar fungus or

form of microorganism, and that it is infectious, this tendency being shown by the loss of the neighboring teeth. Others have ascribed this affection to a peridental inflammation arising from a gouty or rheumatic diathesis.

Treatment.—From what has been said concerning the cause of this affection, it is obvious that a cure cannot always be effected; its progress, however, may sometimes be arrested. The first step in the treatment is to remove all irritants, such as deposits of calculus, from the necks and roots of the teeth, and correct the nature of the fluids of the mouth abnormal in character by constitutional treatment, the use of lime-water, and a detergent dentifrice. Should such means prove ineffectual, the application of a solution of iodin and creosote or carbolic acid, or chlorid of zinc to the margins of the gums will often be of benefit in retarding the absorption and inducing a more healthy action. The secretion of the purulent matter, to the action of which some attribute the destruction of the alveoli, is the result of a disease in the peridental membrane and the edges of the gums, arising from some peculiar physical condition of the teeth, the progress of which may be retarded by cleaning the teeth frequently and thoroughly, using the precaution each time to remove the purulent matter from between the edges of the gums and teeth, lest, if allowed to remain, it should become putrescent, and in this condition act as an irritant to the gum. For this purpose the parts should be washed with a solution of peroxid of hydrogen and bichlorid of mercury (one grain of the latter to the ounce of the former), after which much benefit will be derived by applying a 30 per cent. solution of chlorid of zinc, by means of a camel's-hair brush, to the margins of the gums. As the margin of the gum is inflamed, and a sulcus or pocket formed between it and the tooth, the use of the agents above referred to will promote healthy granulations.

The judicious application of pressure upon the gum has, in some cases, restored the receded portion, to a degree, at least.

Dr. G. V. Black suggests that when there is rapid destruction of the tissue and a considerable portion of the alveolar wall has been destroyed, and much of the peridental membrane detached from the root of the tooth, it is better to cut away some parts of this with instruments until firm bone is felt, but that care should be taken not to injure the gingival margin in any manner. The soft tissue farther up, however, may be lacerated without evil result, but the margin of the gum should be preserved so that it may close around the neck of the affected tooth.

Where it is desirable to preserve a valuable tooth, one of the roots of which has been denuded of gum and process, such root may be

amputated by the use of a fissure-burr operated by the dental engine. The root should be cut off as close to its union with the crown as possible and the surface made smooth. It is advisable to fill all the roots with gold before amputating.

HYPERTROPHY OF THE WALLS OF THE ALVEOLAR CAVITIES.

A tooth is sometimes slowly forced from its place by a deposit of bony matter in the bottom or on the side of the socket. Two, or even three, teeth may be gradually displaced at the same time, by exostosis of the alveoli. The deposition usually proceeds so slowly that one or two years are required to effect a very perceptible change in the situation of a tooth. The upper central incisors are more frequently affected than any of the other teeth, and the deposit occurs oftener at the bottom than on the sides of the alveoli. In the first case, the tooth is gradually protruded from the socket; in the other, it is either pressed out of the arch or against one of the adjoining teeth. Irregularity in the arrangement of the teeth is, in this manner, sometimes produced, especially when more than one socket is affected at the same time. The central incisors are sometimes forced apart; at other times they are forced against each other and caused to overlap. The deposition of bone, however, being generally confined to the bottom of the sockets, the teeth are more generally thrust from their alveolar cavities. When this occurs with a person whose upper and lower teeth strike directly upon each other, it occasions much inconvenience, for the elongated tooth must either be thrown from the circle of the other teeth, or, by striking its antagonist, prevent the jaws from coming together.

Causes —Whereas excessive iritation causes absorption or destructive pathologic conditions, slight irritation may cause new formations; hence, slight, but long-continued irritation of the peridental membrane may produce exostosis of the alveolar cavities; it may also be caused by the gradual elongation of a tooth which has lost its antagonistic teeth, and the consequent filling up of the alveolar cavity. A diseased state of the gums can have no agency in the production of the exostosis, for it most frequently occurs in individuals whose gums are perfectly healthy; and if it were the result of any constitutional tendency, all the teeth would be likely to be affected by it.

Treatment.—When the exostosis is on the side of the alveolar cavity, the tooth cannot be restored to its natural position; but when it is in the bottom of the cavity the elongated organ may, from time to time, as it is forced from the alveolus, be filed or ground off even with the other teeth; but in doing this care should be taken to avoid as much as possible the unpleasant jar which the file or corundum disc is so

apt to cause, and which might, in such cases, excite the peridental membrane to increased activity and a more rapid deposit. This will remove the deformity and prevent its displacement by the antagonizing tooth. By this simple operation, repeated as occasion may require, it is preserved for years, and rendered almost as useful as any of the other teeth. Steady pressure in the proper direction, applied to the crown of a tooth so affected, may also prove serviceable at an early stage.

CHAPTER XI.

DISEASES OF THE TEETH.

NECROSIS OF THE TEETH.

THE term *necrosis* implies death, but when this term is applied to a tooth, it usually signifies loss of vitality of the pulp; for it often happens that a degree of vitality is kept up in the outer portion of the dentine and the investing cementum by the peridental membrane long after the devitalization of the pulp. When other bones are affected with necrosis, the dead part is thrown off and the loss supplied by the formation of new bone. But the teeth are not endowed with the recuperative power which the process of exfoliation calls for.

The density of a tooth may not be sensibly affected by the mere loss of vitality; but so great a change takes place in the appearance of the organ, that it may readily be detected by the most careless observer. After the destruction of the lining membrane, the tooth gradually loses its peculiar semi-translucent and animated appearance, assuming a dingy or muddy-brown color; and this change is more striking in teeth of a soft, than in those of a hard texture. The discoloration, too, is always more marked when the loss of vitality has resulted from a blow, than when produced in a more gradual manner. The discoloration is partly owing to the presence of disorganized matter in the pulp-cavity, and partly to the absorption of this matter by the surrounding walls of dentine.

After the destruction of the lining membrane, the tooth may receive a sufficient amount of vitality from the peridental membrane to prevent it from exerting a manifest morbid influence upon the parts with which it is immediately connected. Teeth have been retained under such circumstances with apparent impunity for many years. But when every part of a tooth has lost its vitality, it becomes an

extraneous body. When this happens, inflammation of the cavity ensues, the gum around it becomes turgid and spongy, and bleeds from the slightest injury, and the organ gradually loosens and ultimately drops out. In the meantime the diseased action frequently extends to the cavities and gums of the adjoining teeth.

The front teeth, being more exposed to injuries from violence, are more liable to necrosis than the molars.

Causes.—Necrosis of the teeth may be produced by a variety of causes, such as protracted fevers, the long-continued use of mercurial medicines, by caries, and by external violence. The immediate cause, however, when not occasioned by a blow sufficient to destroy the vascular connection of the tooth with the rest of the system, is inflammation and suppuration of the lining membrane; but it may result from deficiency of vital energy and from impaired nutrition; for the author has met with several cases in which the loss of vitality could not be accounted for in any other way.

Treatment.—When a tooth deprived of vitality is productive of injury to the gums and to the adjacent teeth, it should be immediately removed; for, however important or valuable it may be, the health and durability of the others should not be jeopardized by its retention.

When necrosis of a tooth is apprehended, we should endeavor to prevent its occurrence by the application of leeches to the gums, and by gargling the mouth with suitable astringent washes, and the employment of such remedies as are useful in the treatment of periodontitis. If this plan of treatment is adopted at an early period, it will sometimes prevent the loss of vitality; but if long neglected, a favorable result need not be anticipated.

When the loss of vitality is confined to the crown and inner walls of the root, if the former is not seriously impaired by caries, it may be perforated, and the pulp-cavity and root cleansed, disinfected and filled in the manner as directed in another part of this work. If the necrosed tooth is an incisor, the perforation should be made from the palatal surface, provided the proximate surfaces are sound. But previously to the introduction of a filling, the decomposed surface of the walls of the pulp-cavity should be completely removed, and if this does not restore the tooth to its natural color, the process of bleaching should be resorted to.

Bleaching Necrosed Teeth.—To improve the appearance of a necrosed tooth which has become discolored from the dentinal tubuli absorbing the coloring matter from the blood, the following method may be pursued: First, remove all decayed matter from the crown-cavity, where such a cavity exists, taking care, however, to leave the enamel uninjured, and also as much of the dentine as is necessary for the

strength of the tooth. Pursue the same course with regard to the canal in the root, cleansing this carefully by means of a syringe and tepid water after the removal of decomposed matter with the nerve canal instruments. When the discoloration is recent and not more than a red tinge in degree, such treatment as has been described may prove sufficient; should it not be, however, owing to the length of time the discoloration has existed, and the hue is a brown, dark brown, or black, it is then necessary to resort to such agents as contain chlorin. Solutions of chlorid of soda, chlorid of lime, chlorate of potash, decompose organic substances by removing the hydrogen of their coloring matter. One of the most reliable of these preparations is the solution of chlorid of soda, known as "Labarraque's Disinfecting Fluid," which may be introduced on a pellet of cotton and allowed to remain in the tooth from thirty to sixty minutes, according to the degree of discoloration present. Repeated applications may be necessary in some cases before the object desired is accomplished. To prevent the caustic action of these agents on the soft parts, the canal in the root should be partly filled prior to their introduction, and care taken to prevent their coming in contact with the mucous membrane of the mouth by the application of the rubber-dam. The chlorid of lime is introduced in the same manner as the chlorid of soda, and is allowed to remain for five, ten, or fifteen minutes at a time, and its application repeated if necessary, the crown-cavity during the interval being protected by a temporary filling of Hill's stopping.

Dry, fresh chlorid of lime made into a paste with dilute tartaric acid has given satisfaction in many cases as a bleaching preparation; and in recent cases or in slightly discolored teeth, the plastic filling material known as oxychlorid of zinc, introduced into the crown cavity and worn as a temporary filling, has been effective in improving the appearance of a discolored crown. Oxalic acid, carefully protected, is also effective as a bleaching agent, applied in the form of a crystal introduced into the carious cavity and dissolved by applying to.it a drop of water. Cyanid of potassium in solution will remove the stains caused by old amalgam fillings, but must be employed with great care, as it is a very active and deadly poison. In the use of all these agents it must be remembered that upon the cause of the discoloration will depend the efficacy of the chemical agent, and that chlorin will answer in some cases, owing to the nature of the agents instrumental in producing the discoloration, while cases of discoloration arising from the action of other agents will require such preparations as oxalic acid, etc.

After the action of the bleaching agent is no longer required a good practice is to fill the crown cavity of the tooth with either prepared

chalk or carbonate of magnesia, which may be secured by a temporary filling, and permitted to remain for several days; or a filling of the oxychlorid of zinc may be temporarily used, and a more permanent filling be subsequently introduced. Chlorid of zinc in the form of crystals may also be employed as a bleaching agent; also chlorin water injected repeatedly by means of a syringe; also chlorate of potash and chlorid of alumina. The peroxid of hydrogen has also been used successfully for bleaching discolored teeth, and its disinfectant properties add to its value. The following directions are given by Dr. A. W. Harlan :—

"After the root has been filled and the tooth is free from tenderness, apply the dam, dry the cavity, and remove all discolored dentine. Wash the cavity several times with fresh peroxid of hydrogen and place a few crystals of chlorid of alumina in the cavity, moisten with the peroxid of hydrogen, and wait from three to five minutes; wash the cavity thoroughly with distilled water, then apply a solution of 30 grains of borax to the ounce of water until the acid is entirely neutralized. Dry the cavity with hot air, and paint the interior with copal-ether varnish. When it is dry mix oxychlorid of zinc of the desired color and fill the cavity full; allow it to harden, then prepare the cavity for the gold filling and fill at once."

The active agent is oxygen, and even when chlorin is used to bleach discolored teeth the cavity should be moistened with water, as the latter is essential, for the chlorin, having a great affinity for the hydrogen of the water, unites with it and liberates the nascent oxygen, which is the active agent.

Peroxid of hydrogen, peroxid of sodium, and pyrozone in five and twenty-five per cent. solutions are effective bleaching agents, especially the latter, which attack the hydrogen in the color compound, and when this is given off only water remains. Dr. Meeker's method is as follows: Apply the rubber-dam, and wipe out the prepared cavity with ammonia to neutralize possible acidity; then with a gold probe armed with a pellet of bibulous paper saturated with the twenty-five per cent. solution of pyrozone, liberally moisten the interior of cavity and outer surface of tooth, evaporating the solution with repeated blasts of cold air. Repeat this treatment, although thirty minutes will often suffice.

Electrolysis is also applied to the bleaching of discolored teeth by placing nascent oxygen in contact with the discolored surface. It is applied, according to Dr. W. B. Ames, as follows: First fill the root and moisten the cavity with acidulated water (one drop to the ounce of water, in order to render it a more effectual electrolyte), then apply a metal electrode connected with the negative pole of the battery in

contact with the moistened surface of the margin of the cavity, and pass a platinum needle, connected with the positive pole of the battery, over the surface to be bleached. Upon closing the circuit the oxygen of the water is liberated at the positive pole near the surface to be bleached, and the hydrogen is liberated at the negative electrode outside the cavity. Electrolysis is also recommended for the treatment of alveolar pyorrhea.

It should be remembered that the effect of these agents is to remove the organic or animal matter from the tooth-structure, and that their repeated application may cause the crown of the tooth to become frail and brittle.

HYPERCEMENTOSIS.

This disease, formerly designated "exostosis of the teeth," but now designated *hypercementosis*, and also *hypcrostosis*, attacks no other part of a fully formed tooth than the root; for in the cementum alone, of the three osseous dental tissues, do we find that degree of vascularity which is a necessary condition of growth—normal or abnormal. It usually commences at or near the extremity, then extends upward, covering a greater or less portion of the external surface. It sometimes, however, commences upon the side of the root and forms a large tubercle; at other times the deposit of the new bony matter is spread over the surface of the root, often uniformly, but more frequently unequally. When it exists in a nodular form upon the roots, this deposit offers a very serious obstacle in the extraction of such teeth. The osseous matter thus deposited has usually the color, consistence, and structure of the cementum, though sometimes it is a little harder and assumes a yellower tinge. The enlargement is in fact an hypertrophied condition of this substance. Mr. Tomes, alluding to normal cementum, remarks: "When it is limited to a thin layer the lacunæ are altogether absent, and even canaliculi do not appear until a certain thickness is attained. In a longitudinal section of a front tooth the cementum near the neck will present a thin layer of transparent tissue, marked with faint indications of granularity, accompanied in some cases with an obscure linear appearance, suggestive of the idea that the calcification of parallel fibres had contributed to its production. Proceeding in the direction of the root, the cement thickens and is traversed here and there by canaliculi; and still farther down lacunæ make their appearance, first as a single series, then, with an increased thickness of the cementum, in numbers, the number generally depending

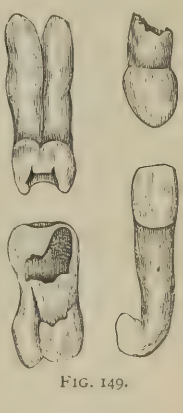


FIG. 149.

upon the thickness of the tissue." Those singular anomalies occasionally met with, where enamel, dentine, and cementum are mixed up in a shapeless confusion, are no exceptions to the rule that hypercementosis is confined to the cementum; for though classed under this head, these cases arise from the disruption of the formative membranes (possibly the result of violence), each secreting its peculiar tissue.

The deposit of osseous matter is sometimes so considerable that the roots of two or more teeth are firmly united by it. Fig. 149 represents some common examples of hypercementosis.

Fig. 150 *a* represents the circumscribed variety, and Fig. 150 *b* the diffused variety.

Hypercement is a product of the peridental membrane, and is formed in layers, the first of which is attached to the primary cementum in the same manner as the first layer of this latter substance is attached to the peripheral surface of the dentine. When the normal

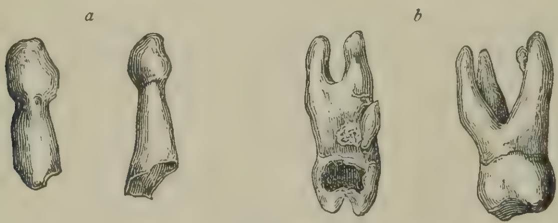


FIG. 150.

cementum is fully formed the peridental membrane becomes inactive as a hard tissue producer, until some pathological condition causes it to again assume such a function.

In one instance the author was compelled to extract four sound teeth and nine roots; yet the pain was not at any time severe, but it was constant and a source of great annoyance to the patient.

Several years ago Prof. Gorgas, while demonstrating practical anatomy, discovered all the teeth in the mouth of one of the subjects (a negro girl about twenty-five years of age) to be in an exostosed condition. On the roots of one of the superior molar teeth the deposit of osseous matter measured three-fourths of an inch in diameter.

Teeth affected with hypertrophy of the cementum may be free from tenderness even under pressure or percussion, although the gum may, in some cases, be slightly congested; but the diagnosis of this affection is extremely difficult unless the enlargement of the root causes a prominence on the alveolar ridge, which is not often the case.

In many but not in all cases of this affection more or less discomfort and pain attend this deposit, owing to the enlargement of the

cementum with consequent pressure upon the nerves. When such an enlargement is in proportion to that of the alveolus, little or no pain may be experienced. The pain arising from the enlargement of the cementum is at times moderate though persistent, but in some cases it may be excruciating, and may be referred to distant parts of the face and head or ear and about the terminal branches of the fifth pair of nerves, thus resembling neuralgia.

Causes.—Most writers concur in attributing the proximate cause of hypertrophy of the cementum to irritation of the peridental membrane ; but this is not, as some suppose, necessarily dependent upon any morbid condition of the crown itself, for it often attacks teeth that are perfectly sound. It seems rather to be attributable to some peculiar constitutional diathesis. Dr. Bödecker believes that a congenital surplus of pericementum in the patient is productive of the enlargement of the cementum, and that in this case the movement of the tooth in mastication would slightly exceed the normal degree, and that the constant irritation of the pericementum under such conditions might cause an increase in the amount of the cementum.

It never makes its appearance on the roots of temporary teeth, nor upon permanent teeth until the sixteenth or twentieth year, when the dental tissues are completely calcified.

Treatment.—When it is possible to discover the existence of hypercementosis at an early stage, iodid of potassium in large doses, and painting the gum over the affected root with such counter-irritants as a saturated tincture of iodin, or cantharidal collodion to produce a blister.

The disease having established itself does not admit of cure, and when it has progressed so far as to be productive of pain and inconvenience to the patient the loss of the affected teeth becomes inevitable. When the enlargement is very considerable and confined to the extremity of the root, and has not induced a corresponding enlargement of the alveolus around the neck of the tooth, the extraction of the affected organ is often attended with difficulty, and can only be accomplished by removing a portion of the alveolar wall of the cavity or fracturing it.

Some are of the opinion, however, that the deposit of osseous matter may be arrested and absorption excited, so as to make room for that already deposited, by the administration of iodid of potassium, as referred to above.

EROSION OF THE TEETH.

Erosion of the teeth, to which the name "denudation" was formerly applied, is a process in which the enamel and dentine of the teeth are dissolved or wasted away, the location of the affection being princi-

pally on the labial surfaces near the cervical margins. The approximal surfaces of the teeth are sometimes the seat of this affection, and in very rare cases it has appeared upon the lingual surfaces. It attacks the incisors more frequently than the canines, and sometimes extends to the bicuspids and first and second molars. It first appears as a slight cup-shaped depression and increases over a limited space until it forms a continuous horizontal groove, as regularly and smoothly constructed as if it had been made with a file, about one line or less from the free margin of the gum, the eroded surface being generally very sensitive, having a polished appearance and being sharply defined. (See Fig. 151.) After it has removed the enamel it commits its ravages upon the subjacent dentine, sometimes penetrating to the pulp-cavity. It rarely changes the color of the enamel, but the dentine, after it becomes exposed, assumes first a light, and afterward a dark brown color, retaining, however, a smooth and polished surface. This destructive process does not always commence at merely one point on the labial surface of the central incisors, as just described; it some-

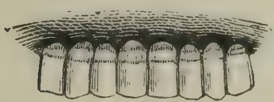


FIG. 151.

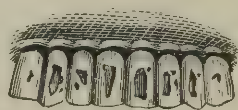


FIG. 152.

times attacks several points simultaneously. (See Fig. 152.) As it spreads these unite, and ultimately a deep excavation is formed with walls so smooth and highly polished that the tooth presents the appearance of having been scooped out with a broad, square, or round-pointed instrument. It is often confined to the incisor and canine teeth, and in some cases to the teeth on one side of the mouth only. This affection generally appears after the thirtieth year of age, and when the eroded surfaces become rough the change is generally due to the action of caries.

The progress of the affection is exceedingly variable. It is sometimes so rapid that the dentine becomes exposed within two or three years from the commencement of the disease; at other times its effect upon the enamel is scarcely perceptible for the first six or eight years after it makes its appearance. In the case of a lady whose teeth were thus affected the denuding process did not perforate the enamel for nearly twenty years. The dentine, after it is denuded of enamel, is generally quite sensitive and very susceptible to heat and cold; this is especially the case with the superior canines.

Causes.—Some writers suppose it is occasioned by chemical action, to which, however, there appears to be many valid objections. Mr.

John Tomes and also Mr. Salter ascribe it to the vigorous use of the tooth-brush or other friction, but such a cause is improbable. That this may increase the size of the horizontal groove is more than probable; that it may even in some cases determine the commencement of the groove is just possible. But no conceivable action of the brush could be an inciting cause of that form of the disease shown in Fig. 152. There is better reason for believing that this affection is due to a condition of enamel deficient in vital resistance, owing to some modification at the period of its formation, thus rendering it susceptible to the action of agents which it might, under more favorable circumstances, successfully resist; but microscopical examinations have failed to establish such a theory, as, according to Dr. Black, the erosion does not follow the developmental lines, which would be the case if portions of the teeth could be worn away on account of any softness from faulty development. The generally accepted theory is that this affection is caused by the action of an acid secretion, abnormal in character, or such constitutional acidity as may be present in a gouty diathesis, the movements of the lip assisting in the solution of the tooth-substance. Dr. W. D. Miller records the following experiment, which he regards as definitely settling the question as to whether or not erosion occurs in pulpless teeth: "We have all seen pulpless teeth which presented extensive erosions, but we have not been able to say that these erosions were not produced while the pulp of the tooth was still alive, and, as far as I am aware, no one has succeeded in refuting beyond all doubt the assertion that erosion attacks only teeth with living pulps. On the 7th of April, 1886, a piece of ivory was set, by means of cement, in the cavity of a right inferior bicuspid, where the loss of substance by erosion was so extensive that it would have exposed the pulp if the latter had not been protected by secondary dentine. On the 23d of April, 1888, the piece was removed for examination, and showed two very distinct parallel horizontal furrows. The surface had a very fine polish, characteristic of abraded dentine. No one examining the piece of ivory would hesitate for a moment to pronounce it a typical case of erosion."

Treatment.—In advanced stages of the affection its progress may be arrested by properly preparing the cavities and afterward filling them with gold; or, if the defective spaces will permit, porcelain sections or facings may be inserted. This, in the majority of cases, will prove successful. Should the grooves or pits when superficial become discolored it will be proper to use occasionally pumice or silex applied on a point of wood.

Erosion Associated with Abrasion.—This process was formerly treated under the title of "Chemical Abrasion," but as it appears to

be an affection of the teeth in which the effects of both erosion and abrasion from mechanical causes are combined it is considered under the head of erosion. It is of comparatively rare occurrence and commences on the central incisors, proceeding thence to the laterals, the cuspids, and sometimes, though very rarely, to the first bicuspids. Teeth thus affected have, when the jaws are closed, a truncated appearance; the upper and lower teeth do not come together, and they are rather more than ordinarily susceptible to the action of acids or of heat and cold. In other respects little or no inconvenience is experienced until the crowns of the affected teeth are nearly destroyed.

Its progress, as in the case of simple abrasion of the labial surfaces, is exceedingly variable. It sometimes destroys half or two-thirds of the crowns of the central incisors in two or three years; at other times seven or eight years are required to produce the same effect. In one case which came under our own observation the abrasion had extended to the bicuspids, and the central incisors of both jaws were so much wasted that on closing the mouth they did not come together by nearly three-eighths of an inch; yet two years only had elapsed since its commencement. In another case, where it had been going on for seven years, it had not extended to the cuspids, and the space between the upper and lower incisors did not exceed an eighth of an inch. The subjects of these two were gentlemen—the first aged about twenty-eight and the other twenty-one.

FIG. 153.

Mr. Bell gives an interesting case (Fig. 153) of a gentleman whose teeth were thus affected: "About fourteen months since (1831) this gentleman perceived that the edges of the incisors, both above and below, had become slightly worn down, and, as it were, truncated, so that they could no longer be placed in contact with each other. This continued to increase and extend to the lateral incisors, and, afterward, successively to the cuspids and bicuspids. There has been no pain, and only a trifling degree of uneasiness, on taking acids or any very hot or cold fluids into the mouth. When I first saw these teeth they had exactly the appearance of having been most accurately filed down at the edges and then perfectly and beautifully polished; and it has now extended so far that when the mouth is closed the anterior edges of the incisors of the upper and lower jaws are nearly a quarter of an inch asunder. The cavities of those of the upper jaw must have been exposed but for a very curious and beautiful provision; they have become gradually filled by a deposit of new bony matter, perfectly solid and hard, but so

transparent that nothing but examination by actual contact could convince an observer that they were actually closed. This appearance is exceedingly remarkable, and exactly resembles the transparent layers which are seen in agatose pebbles, surrounded by a more opaque mass. The surface is uniform, even, and highly polished, and continues, without the least break, from one tooth to another. It extends at present to the bicuspids, is perfectly equal on both sides, and when the molars are closed the opening, by this loss of substance in front, is observed to be widest in the center, diminishing gradually and equally on both sides to the last bicuspids."

The same causes may be ascribed for this affection as for those of erosion and abrasion. There is apparently some constitutional acidity due to a gouty diathesis, the effect of which upon defective tooth-structures renders the central portions of the tooth-surface susceptible to both erosion and mechanical abrasion, and the latter process may account for the smooth and polished surfaces which are invariably present.

From the fact that teeth thus affected continue to lose structure much more rapidly than the unaffected teeth of the same mouth do from mastication, and this, too, even after they cannot be brought in contact with each other, we cannot ascribe the affection to mechanical abrasion alone.

Dr. Black remarks that "the effect is certainly that of erosion, and is identical with that process as seen on the labial surfaces of the teeth and occurring independently of mechanical abrasion."

The only treatment for such cases is that of restoration, either by means of capping with gold or the attachment of sections of porcelain crowns, as no local therapeutic treatment will control or arrest this singular disease.

MECHANICAL ABRASION OF THE TEETH.

Mechanical abrasion of the teeth is a process of attrition which results in a loss of substance, the progress of which depends upon the consistence of the tooth structures and the amount of friction to which the abraded tooth is subjected. Such a loss of substance is the result of imperfect articulation, the loss of masticating teeth, the nature of the food used, the action of hard substances upon natural teeth, such as porcelain teeth, the stems of clay pipes, the chewing of tobacco, etc., etc. Enamel and dentine, once formed, pass beyond the sphere of that reparative power found in other bony tissues where red blood circulates freely. New enamel is therefore never formed after the eruption of the tooth; and new dentine only within the pulp-cavity by the action of the odontoblasts.

The teeth rarely suffer much loss of substance from friction when the incisors of the upper jaw shut in front of those of the lower. It is only when the former fall directly upon the latter that mechanical abrasion of the cutting edges of the front teeth can take place, and when this happens, they sometimes suffer great loss of substance. The crowns of these teeth are occasionally worn entirely off, while those of the molars and bicuspids are, comparatively, little affected. The lateral motions of the jaw, being in these cases unrestricted—and this motion being, of course, greater at the anterior than at the posterior part of the mouth—it necessarily happens that the front teeth suffer the most abrasion. Sometimes all the teeth are worn off alike; at other times, owing to the peculiar manner in which the jaws come together, the abrasion is confined to a few.

Abraded surfaces of teeth often become very sensitive, and the irritation affects the dental pulp in such a manner as to often favor the deposit of secondary dentine, the site of the deposit corresponding to the abraded surface.

The rapidity of the abrasion depends greatly upon the manner in which the teeth antagonize, as sliding movements when the jaws are closed cause abnormal wear of the two surfaces. No doubt the grinding together of the teeth during sleep, the effect of nervousness, also facilitates the abrasion.

Abrasion is frequently caused by the loss of a number of teeth, which necessarily brings the entire work of mastication upon the remaining ones to such a degree as to rapidly wear them away, especially when the latter are few in number.

Mr. Bell believed that certain kinds of diet tend, more than others, to produce abrasion of teeth; in proof of which he referred to sailors who, the greater portion of their lives, live on hard biscuits, and have only a small part of the crowns of their teeth remaining. But the antagonism of the teeth has much more to do with it than the nature of the food; though, of course, when they do strike in such a way as to wear the cutting surfaces, very hard or gritty articles of food would make the abrasion more rapid.

When the front teeth of the lower jaw strike against the palatine surface of those of the upper, the latter are sometimes worn away more than three-fourths, and in some instances entirely upon the gums. We have seen the teeth of some individuals so much abraded in this way, that little of the crown remained, except the enamel on the anterior surface.

The wearing away of the crowns of the teeth would sooner or later expose the pulp, were it not that nature, in anticipation of the event, sets up an action by which layers of odontoblasts of the pulp resume

their functional activity, and a portion of the organ, or the entire mass of it, at times is transformed into secondary dentine. By this beautiful operation of the economy, the painful consequences that would otherwise result from the exposure of the pulp are wholly prevented.

Treatment.—The early correction of irregularities in the arrangement of the teeth, so that a proper antagonism of the teeth is secured, by which the cusps will fit into sulci of the opposing teeth, may be suggested as preventive treatment in many cases.

After the abrasion has occurred, the adaptation of caps of gold or other metal, or gold in the form of contour fillings, or enamel sections, to the cutting edges and grinding surfaces thus worn away, or the insertion of artificial masticating teeth, will often preserve and render useful teeth in such a condition, and prevent further abrasion.

FRACTURES AND OTHER INJURIES OF THE TEETH FROM MECHANICAL VIOLENCE.

The injuries to which teeth are subject from mechanical violence are so variable in their character and results as to render a detailed description impossible. The same amount of violence inflicted upon a tooth does not always produce the same effect. The nature and extent of the injury will depend as much upon the physical condition of the teeth, the state of the constitutional health, and the susceptibility of the body to morbid impressions, as upon the violence of the blow. Thus, a blow sufficiently severe to loosen a tooth might not, in one case, be productive of any permanent bad consequences; while in another it might cause the death of the organ and inflammation of the adjacent parts, as well as necrosis of the alveolus.

A tooth of compact texture, and in a healthy mouth, may be deprived of a portion of its substance without any serious injury; but a similar loss of substance in a tooth not so dense in structure would be likely to produce inflammation and suppuration of the pulp, and possibly of the peridental membrane. Hence, in order to form a correct opinion of the result of injuries of this sort, we must take into consideration not only the character of the tooth upon which the blow has been inflicted but also the state of the mouth and the health of the individual.

If the tooth is not loosened in its cavity any injury resulting from a loss of a small portion of the enamel, or even of the dentine, may be prevented by smoothing the fractured surface with a file or corundum disc or point, that the fluids of the mouth and particles of extraneous matter may not be retained in contact with it. But if the tooth is loosened and pulpitis or periodontitis has supervened, leeches should

be applied to the gums, and the mouth washed several times a day with some anodyne and refrigerant lotion, until the inflammation subsides. For more detailed treatment the reader is referred to the chapters on periodontitis and pulpitis.

When a tooth has been displaced from its cavity by a blow, and its vascular connection with the general system destroyed, necrosis is very prone to occur. An imperfect union between the tooth and alveolus may sometimes be re-established by the effusion of a coagulable lymph and the formation of an imperfectly organized membrane; but the tooth may after, from the slightest cold or derangement of the digestive organs, be liable to become sore to the touch, and in most cases will ultimately assume a discolored appearance.

The author has, on several occasions, replaced teeth that had been knocked from their cavities; and in some instances the operation was attended with success. The subject in one case was a healthy boy of about thirteen years of age, who, while playing bandy, received a blow from the club of one of his playmates, which knocked the left central incisor of the upper jaw entirely out of its cavity. He saw the boy about fifteen minutes after the accident. The alveolus was filled with coagulated blood. This he sponged out, and after having bathed the tooth in tepid water, carefully and accurately replaced it in its socket, and secured it there by silk ligatures attached to the adjacent teeth. On the following day the gums around the tooth were considerably inflamed, to reduce which inflammation he directed an application of three leeches and the frequent use of an anodyne and refrigerant lotion (solution of acetate of lead combined with tincture of opium). At the expiration of four weeks the tooth became firmly fixed in its cavity, but the tooth protruded somewhat, and slight soreness is experienced on taking cold (the result, no doubt, of the retention of a dead pulp.)

Numerous cases have occurred of replanted teeth which were properly prepared before re-insertion, by filling of pulp-canals after the removal of the dead pulp, becoming firmly fixed.

The alveolar processes and jaw-bones are sometimes seriously injured by mechanical violence. The author was requested by the late Dr. Baker, of Baltimore, to visit with him a lady who, by the upsetting of a stage, had her face severely bruised and lacerated. All that portion of the lower jaw which contained the six anterior teeth was splintered off, and was only retained in the mouth by the gums and integuments with which it was connected. The wounds of her face having been properly dressed, the detached portion of the jaw was carefully adjusted and secured by a ligature passed around the front teeth and first molars, and by a bandage on the outside, around the chin and back

part of the head. Her mouth was washed five or six times a day with diluted tincture of myrrh. The third day after the accident Dr. Baker directed the loss of twelve ounces of blood; and in five or six weeks, with no other treatment than the dressing of the wounds, she perfectly recovered.

It often happens that the crown of a tooth is broken off at the neck. We have known the crowns of four, and in some cases of thirteen, teeth to be fractured by a single blow. The subject of the last case was a fireman, who received an accidental blow on his mouth from the head of an axe, which broke off the crowns of all the upper and lower incisors, two cuspids, and three of the bicuspids of the inferior maxilla. The subject in the other case was a boy about twelve years of age, who, from a similar accident, occasioned by running up suddenly behind a man who was chopping wood, had the crowns of his upper incisors broken off. In both of these cases the inflammation which supervened was so great as to render the removal of the roots necessary. The crowns, roots, and alveolar processes are sometimes ground to pieces, or the teeth driven into the very substance of the jaw. Mr. Bell says he once found a central incisor so completely forced into the bone that he thought it to be the remains of a root; but, on removing it, found it to be an entire tooth.

When the crown of a tooth has been broken off by a blow, and destructive inflammation results, the root should be extracted. When, however, the injury has not been sufficient to cause such a degree of inflammation, an artificial crown may be engrafted on the root; but it is very necessary that the inflammation should be entirely subdued previous to the operation of crowning. If the tooth is to be replaced with an artificial substitute attached to a plate, the root should be first extracted, unless it is adapted to serve as a support for a section of bridge-work. In some cases, however, the root may be filled and be permitted to remain, but the practice is usually a bad one. The possibility of a fractured tooth reuniting was formerly doubted, but Wedl, in his "Pathology of the Teeth," refers to some fifteen cases in which union took place, some of which he ascribed to the formation of secondary dentine and others to that of cementum.

CARIES OF THE TEETH.

There is no affection to which the teeth are liable more frequent in its occurrence or fatal in its tendency than caries. It is often so insidious in its attacks and rapid in its progress that every tooth in the mouth may be more or less involved before even its existence is suspected.

Its presence is usually first indicated by an opaque or dark spot on the enamel, and if this be removed the subjacent dentine will exhibit

a black, dark-brown, or whitish appearance. It usually commences on the outer surface of the crown, at some point where the enamel is imperfect or has been fractured or otherwise injured, or on the surface of the dentine when this structure becomes exposed; from thence it proceeds toward the centre of the tooth, increasing in circumference until it reaches the pulp-cavity.

If the diseased part is of a soft and humid character the enamel, after a time, usually breaks in, disclosing the ravages the disease has made on the subjacent dentine. But this does not always happen; the form of the tooth sometimes remains nearly perfect until its whole interior structure is destroyed.

No portion of the crown or neck of a tooth is exempt from this disease; yet some parts are more liable to be first attacked than others; as, for example, the depressions in the grinding surfaces of the molars and bicuspids, the approximal surfaces of all the teeth, the posterior or palatine surfaces of the lateral incisors, and, in short, wherever an imperfection of the enamel exists.

The enamel is much harder than the dentine, and is by far less easily acted on by the causes that produce caries. It is sometimes, however, the first to be attacked, and when this happens the disease develops itself more frequently on the labial or buccal surface, near the gum, than in any other locality, often commencing at a single point, and at other times at a number of points. When the enamel is first attacked it is usually called erosion; but as this tissue does not contain so much animal matter as the subjacent dentine, the diseased part is often washed away by the saliva of the mouth, while in the dentinal part of the tooth it, in most instances, remains, and may be removed in distinct laminæ, after the earthy salts have been decomposed.

FIG. 154.
* A transparent zone of dentine removed a short distance from and surrounding that which is undergoing decomposition consequent upon caries.

In very hard teeth the decayed part is of a firmer consistence and of a darker color than in soft teeth. Sometimes it is black, at other times of a dark or light brown, and at other times again it is nearly white. As a general rule, the softer the tooth, the lighter, softer, and more humid the caries. The color of the decayed part, however, may be, and doubtless is in some cases, influenced by other circumstances; perhaps by some peculiar modification of the agents concerned in the production of the disease.

Commencing externally beneath the enamel, the disease proceeds,

as before stated, toward the center of the tooth, destroying layer after layer, until it reaches the pulp, leaving each outer stratum softer and of darker color than the subjacent one.

The dentinal tubuli become less distinct near the margin of the carious structure than is the case in the perfectly normal tissue in proximity with the pulp-chamber, and, according to Mr. John Tomes, has a zone-like form (the zone of Tomes, Fig. 154), which he regards as a consolidation of the dentinal tubuli, an effort on the part of nature to place a line of demarcation between the healthy and carious structure.

Other writers, however, consider this zone of transparency to be the result of diseased action causing a complete exclusion of air from the tubuli, thus rendering them invisible when viewed by transmitted light.

The terms *deep-seated*, *superficial external* and *internal*, *simple* and *complicated*, have been applied to the disease. These distinctions only designate different stages of the same affection. By complicated decay is meant caries which has penetrated to the pulp-cavity of the tooth, accompanied by inflammation and suppuration of the pulp.

The roots of the teeth frequently remain firm in their cavities for years after the crowns and necks have been destroyed; but nature, after the destruction of the crowns, as if conscious that the roots are of no further use, exerts herself to expel them from the system, which is effected by the gradual wasting and filling up of their cavities. After this operation of the economy has been accomplished they are frequently retained in the mouth for months, and even for years, by their membranous connection with the gums.

Differences in the Liability of Different Teeth to Decay.—Having explained at some length, in a preceding part of this work, the manner in which the physical condition of the teeth is influenced, it will not now be necessary to dwell upon this portion of the subject. It will only be requisite to state, therefore, that teeth which are well formed, well arranged, and of a firm texture, seldom decay, and when they are attacked the progress of the disease is not rapid; whereas those that are imperfect in their formation and of a soft texture are more susceptible to the action of the causes which produce it; and when assailed, if the progress of the affection is not arrested by art, they usually fall speedy victims to its ravages. Just in proportion as the dentinal structure of the teeth is hard or soft, the shape of the organs perfect or imperfect, their arrangement regular or irregular, is their liability to caries diminished or increased.

The density, shape, and arrangement of the teeth are influenced by the state of the general health, and that of the mouth at the time of their dentinification and amelification. If at this period all the func-

tions of the body are healthily performed these organs will be compact in their structure, perfect in their shape, and usually regular in their arrangement. That the teeth should be thus influenced will not appear strange when we consider, as Richerand remarks, "that there exist amongst all the parts of the living body intimate relations, all of which correspond to each other and carry on a reciprocal intercourse of sensations and affections. Hence, if there is a morbid action in one part, other parts sympathize with it, rallying, as if sensible of the mutual dependence existing between them, all their energies to rescue their neighbor from the power of disease."

Increased action in one portion of the system is generally followed by diminished action in some other part; thus, for example, gastritis may be produced by constipation of the bowels; puerperal fever by diminished action in the heart, with an increased action in the uterus, etc. Hence, we may conclude that if the body at an early age be morbidly excited, its functions will be languidly performed, the process of assimilation checked, the regular and healthy supply of earthy matter in the bones interrupted, and, consequently, that the teeth which are then formed will be defective. Other parts of the body, in which constant changes are going on, if thus affected at these early periods, may afterward recover their healthful vigor; but if the teeth are badly formed they must ever, because of their low degree of vascularity, continue so; hence they will be more liable to decay than when dentinified under other and more favorable circumstances.

Capillary blood-vessels form a large part of every organ, the characteristic tissue of each being strictly *extra-vascular* (literally, *outside of the vessels*). Where the blood-vessels are most abundant, as in the nervous and muscular structures, growth and change take place rapidly and constantly, since almost every particle of the extra-vascular or interstitial tissue is in contact with the circulating fluid, the function of which is to supply material for growth and carry off waste matter. Hence such organs have great recuperative power and are modified by the varying conditions of the body. But the dentine and enamel of the teeth, when once formed, do not possess such a degree of vascularity as will restore carious tissues, although the pulp may deposit new structure in the form of secondary dentine as a barrier against its exposure.

Most writers are of opinion that the power of the teeth to resist the various causes of decay is sometimes weakened by a change brought about in their physical condition through the agency of certain remote causes, such as the profuse administration of mercury, the existence of fevers, and all severe constitutional disorders.

Severe constitutional disorders, and the administration of certain

kinds of medicine, may not act directly on the teeth by altering their physical condition, and thus rendering them more susceptible to the action of corrosive agents; but they are indirectly affected in proportion as the secretions of the mouth are vitiated and their corrosive properties increased.

The formation, arrangement, and physical condition of the teeth are sometimes influenced by hereditary diathesis, affecting the parts concerned in their production or the general system. That a morbid condition of the system on the part of either parent often predisposes their progeny to like affections is an axiom fully recognized in pathology, and a fact of which we have many fearful proofs.

That there is an hereditary tendency in the teeth to decay cannot be denied. But we believe it to be the result of the transmission of a similarity of action in the parts concerned in the production of these organs; so that the teeth of the child are, in form and structure, like those of the parent whom it most resembles, and from whom it has inherited the diathesis. The teeth of the child, if shaped like those of the parent, possessing a like degree of density, and similarly arranged, are equally liable to disease; when exposed to the action of the same causes they are affected in like manner and usually at about the same period of life. Such being the fact, is it unreasonable to conclude that judicious early attention may so influence the formation and arrangement of the teeth that their liability to disease may be diminished? Medicinal remedies and sickness have a powerful influence upon the dental tissues; first, through hereditary transmission of an impaired constitution; secondly, by their action upon the process of development, if given while the teeth are being formed. It is, then, to the differences in the physical condition and manner of arrangement of these organs—whether in different individuals or in the same mouth—that the difference in their liability to decay is attributable.

Dr. John Allen years ago remarked: "The nutritious substances in the food that we take are intended to build up all parts of the system—the hard tissues as well as the soft tissues. Of the food intended to build up these organisms, certain portions make bone and teeth. Now the particles of matter are deposited atom by atom, and the system is gradually built up. When we take food into the system it is converted into blood. This blood is conveyed through all parts in little corpuscles, which are freighted with the proper constituents to sustain and build up these organisms. These little corpuscles convey such constituents as are necessary for the production of bone, teeth, flesh, and the fat, and these various substances are deposited just where they should be. Now it is essentially necessary that we have these little

vesicles freighted with the proper constituents, and duly freighted. How shall we know this? By taking the food just in the proportion that it is provided for us by our Creator and as it comes from nature's laboratory.

"Now we take this ground from the fact that, as a nation, we have worse teeth than any other on the earth. Now why is this? Simply because we change the proportions of these various constituents that our Creator has provided for us, by separating away what has been put there for the building up of the hard tissues.

"To prove this, let us look to other nations. They that do not change the proportions of the various constituents that enter into their bodies do not have decayed teeth.

"There is a constant change going on, and particles of matter are deposited atom by atom, and the system kept fully charged with the mineral elements of which these structures are built up. When you look at nations that do not change the proportions, you see no decayed teeth, and the history of these nations proves that their teeth are sound and beautiful to old age. What is the condition in our country? We *do* change these proportions. We *do* ignore the mineral elements provided for us, and we *do* have decayed teeth. We find that there are over twenty millions of teeth swept from our population every year. We do not take the material into our system that carries back, atom by atom, and keeps the hard tissues built up until the old particles pass away. The old particles pass away after they have served their purpose, and new ones then take their places.

"It is estimated that every child uses half a barrel of flour every year; and it is estimated that there are forty pounds of the bone-forming material thrown out from every barrel that we use. The child takes its food on fine flour, and is deprived of twenty pounds in a year of this mineral element, which should be taken into the system in order to make those hard, flinty substances that our Creator intended. Now, by the time that child is twenty years of age it has been deprived of four hundred pounds of the elements which should have been taken into the system, and would have kept it charged sufficiently to have preserved these substances hard and flinty, as they should be.

"We sweep from our American population over twenty millions of teeth every year, and this should prove the theory that our tissues do undergo a change, and that, particle by particle, they pass away. As it is now, the teeth are becoming worse and worse every year; and not only this, but it becomes hereditary, and is transmitted from parent to child."

Predisposing Causes of Dental Caries.—The causes of dental caries are divided into predisposing and exciting; among the former may be

enumerated a defective constitution, either innate in the child as derived from the parent, or acquired from accidental influences to which the child has been exposed. Any condition of the system that will interfere with the proper elimination and application of the materials necessary for the formation of perfect structures may have a deleterious influence upon the teeth. Hereditary defects are quite common, the teeth of the child exhibiting the peculiarities of those of the parents. Impaired or diminished vitality from constitutional or local causes is also a predisposing cause of dental caries. Febrile conditions not only impair or diminish vitality, but change the nature of the fluids of the oral cavity to such a degree as to cause them to act upon the teeth very injuriously. Dr. George Watt remarked that "all diseases tend to weaken the dental organs, and thus are predisposing causes of decay. The most virulent are the *eruptive fevers*, such as typhus, typhoid, and scarlet fevers, measles, smallpox, erysipelas, etc. These fevers, and perhaps all diseases, predispose to decay in two ways. Weakening the entire constitution, they correspondingly impair the vitality of the teeth, and thus they have less power to resist the encroachments of the exciting causes of decay. And further, they deprave the secretions of the salivary glands and the oral cavity, rendering them liable to such decomposition as will result in the formation of exciting causes. That the condition of the teeth is influenced by heredity, no observing dentist can doubt. We have seen a family in which its female members, for four generations, lacked the left upper lateral incisor. Sometimes one parent has good teeth, and good dental organs pertain to the family history, and the case with the other parent is just the reverse; we see children not usually having dental organs of an average between the two parents, but some of them copying one parent and some the other. The constitution of the parents, and especially that of the mother, may be unable to impart due vigor or proper materials in requisite quantities to the process of developing the teeth. From some cause, hereditary or otherwise, there may be a lack of lime salts in the system, or a lack of physiological ability to appropriate them and build them in properly with the organic matter of the teeth. Another condition may show the very best formed teeth while the alveolar processes, periosteum, and mucous membrane may be defective. A defective periosteum cannot give efficient nutrition; deficient development of the alveoli results in ineffectual support; while if anything is wrong with the mucous membrane we may have to contend with defective or depraved secretions." Dyspepsia affords an example of both a predisposing and an exciting cause of caries, as its effect is to generate an acid in the stomach which, by eructation, is brought into direct contact with the teeth. Malaria is a predisposing cause of dental caries,

on account of the unfavorable conditions it induces; also such medicinal agents as vitiate the oral fluids and irritate the mucous membrane and periosteum, and interfere with the functions of the mucous follicles and salivary glands—mercury, for example; also salivary calculus, by its irritating effects upon the soft tissues in connection with the teeth and its influence upon the oral secretions; also want of exercise, which affects the stability of the teeth and causes absorption of the alveoli; also want of cleanliness, which may be regarded as one of the most common of the predisposing causes of dental caries; also artificial teeth improperly inserted or composed of bad materials; also improper dental operations, both as regards manner and time; also diseased teeth and roots, which are productive of irritation to the peridental membrane and gums; also sudden changes of temperature, which may cause an exalted sensibility of the dentine, diminish the vitality of the teeth, or produce checks in the enamel of frail teeth.

The fissures and grooves on the crowns of the molars and bicuspids are ascribed by some to an arrest of development, a failure of the enamel covering in its formation from the cusps toward the center of the crown to come together and coalesce. Others, however, ascribe these defective places to be due to a rupture of the enamel organ at these points—a separation of the ameloblastic layer, thus separating the enamel rods and forming a fissure; such fissures being more common in teeth with prominent cusps.

Exciting or Immediate Causes.—The exciting or immediate cause of dental caries is conceded to be the action of agents chemically disintegrating the hard structures of the teeth, and which have their source in the vitiated secretions of the mouth, abnormal secretions from the stomach, the saliva, the mucus, and the decomposition of animal and vegetable substances. The theory that the decay of the teeth is the result of the action of external agents was first distinctly suggested to the dental profession of the United States about the year 1821, by Drs. L. S. and Eleazer Parmly. The late Professor Westcott, by a series of experiments made in 1843, found that "acetic and citric acids so corroded the enamel in forty-eight hours that much of it was easily removed with the finger-nail, and malic acid or the acid of apples, in its concentrated state, also acts promptly upon the teeth. Dr. W. D. Miller, an American dentist practicing in Berlin, deserves great credit for many careful investigations made to determine the cause of dental caries. He has given the results of over three hundred experiments, and has cultivated bacteria in order to determine the nature of a new fungus which is always found in the mouth and in carious dentine, and which is said to be always accompanied by a strong acid. Dr. Miller maintains that caries are caused either by the casual intro-

duction of strong acids into the mouth or by the weaker acids formed by the fermentation of farinaceous or saccharine particles of food. After the destruction of the enamel, the process of disintegration attacks the organic matter, and first of all the micro-organism, which causes an endless variety of changes in the dentine, until finally it presents the appearance of a mass of decomposed matter intersected in every direction with fungi. Dr. Miller asserts that he has been convinced, by an examination of several hundreds of specimens, that after decalcification has taken place, the only change of any importance which occurs is produced by micro-organisms. And he further says that he sees "the need of little or nothing more than organic acids and fungi to account for all the phenomena of dental caries." "Give me these two factors and I can produce caries which will deceive the most experienced operators and microscopists."

FIG. 155.—LONGITUDINAL SECTION OF A CARIOUS BICUSPID.

FIG. 156.—UNDERMINING ENAMEL DECAY. *a.* Masses of Bacteria Lining the Cavity. Magnified about 50 Diameters.

Dr. Miller sums up in the following propositions the results of his investigations on the subject of dental caries:—

First. The contact of saliva with amylaceous or saccharine food (not to speak of nitrogenous food), or a solution of sugar or starch in saliva, kept at body temperature, invariably gives rise, in four or five hours, to a strong acid reaction, due to the generation of an organic acid.

Second. There must consequently be in the human mouth a constant, though variable, generation of acid, because of the impossibility of keeping the mouth perfectly free from food and from solutions of amyloids in saliva, which penetrate cracks, pits, and fissures, or are held by capillary attraction between the surfaces of the teeth in contact and there become acid by fermentation.

Third. The degree of acidity depends somewhat upon the length of time which has elapsed since partaking of food, and will be found greatest on rising in the morning.

Fourth. A cavity of decay in which saccharine or amylaceous food has remained for some hours must and will be found, always and without exception, to have an acid reaction.

Fifth. The extent to which any tooth suffers from the action of the acid depends upon its density and structure, but more particularly upon the perfection of the enamel and the protection of the neck of the tooth by healthy gums. What we might call the perfect tooth would resist indefinitely the same acid to which a tooth of opposite character would succumb in a few weeks.

Sixth. An occasional possible absence of an acid reaction in a cavity of decay is no indication that acid has not participated in the production of the cavity. Little or no value can be attached to tests of the saliva alone.

Seventh. Any general or special disorder or condition of the system which results in the withdrawal of lime salts from a tooth, or in a lowering of its density, or in a weakening of the chemical union between the organic and inorganic matter of the tooth, renders it more liable to decay.

Eighth. Strong acid and corroding substances brought but momentarily into the human mouth may give rise to lesions of the enamel at points where the ordinary agents alone could never have begun.

Ninth. All the microscopic appearances and characteristics of caries may be produced with the greatest exactness *out* of the mouth, simply by subjecting teeth to those acid mixtures which are constantly to be found *in* the mouth.

Tenth. The superficial layers of carious dentine undergo an almost if not absolutely complete decalcification, which decreases as we approach the normal dentine. The same is true of dentine decalcified in saliva and bread.

Eleventh. The destruction of the organic constituents follows (not precedes) the decalcification, and is evidently, for the most part, to be ascribed to the action of fungi.

Twelfth. The fungi found in the human mouth do not participate *directly* in the process of decalcification. The exact part which they

perform in the production of an acid reaction requires further investigation.

Thirteenth. The fungi produce the most manifold anatomical changes in the softened dentine, resulting in the complete obliteration of the structure and final disappearance of the tissue in a mass of debris and fungi.

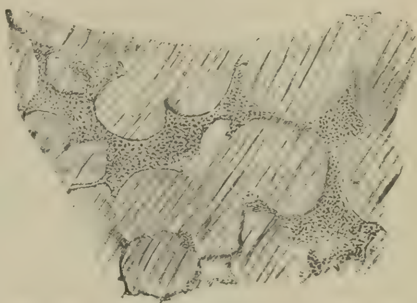


FIG. 157.—INTERGLOBULAR SPACES FILLED WITH MICROCOCCI.
Magnified about 400 Diameters. (*Bödecker.*)

Fourteenth. The invasion of the micro-organisms is always preceded by the extraction of the lime salts.

Fifteenth. The destruction of the tissue remaining after decalcification is effected almost wholly by fungi alone.

Sixteenth. Inflammation can hardly be looked upon as a very important factor in caries of the teeth.

Seventeenth. Caries of the enamel is purely chemical, the decalcification resulting at once in the complete dissolution of the tissue.

Eighteenth. Caries of cement runs a course analogous to caries of dentine, a softening of the tissues by acids, and following this its destruction by fungi; a slight inflammatory action on the part of the living matter in the corpuscles is not to be excluded.

FIG. 158.—DECAYED DENTINE.
Showing total liquefaction of the basis-substance by bacteria. Magnified 400 diameters. (*Bödecker*).

Dr. Frank Abbott, after a careful investigation of the etiology of dental caries, concludes that the first lesion is due to the action of an acid, which in a merely chemical way dissolves out the lime salts from the enamel, and that such an acid is generated from the decaying material found in the food, mainly in such kinds of foods as through their decomposition are apt to produce an acid possessing a

high degree of affinity for lime salts, viz.: lactic acid. He also believes that the organic portion of teeth, as it advances to the stage of decomposition in the process of caries, plays a very important part in the formation of this acid; and that perhaps the sour decomposition is assisted locally by the action of micrococci and leptothrix, and he concurs with the views of those who claim that the resistance of the teeth against caries, owing to their amount of lime-salts, greatly varies in different people; that on a dead tooth, natural or artificial, as well as on teeth made from the dentine of the elephant or the hippopotamus, the process will remain under all circumstances a chemical one, assisted only by the putrefying remains of the organic material of the tooth; while on a live tooth either acute or chronic reaction changes take place. Dr. Abbott sums up the results of his researches as follows: "I. In enamel, caries in its earliest stages is a chemical process. After the lime salts are dissolved through the inflammatory reaction, and the basis-substance liquefied, the protoplasm reappears and breaks apart into small, irregularly shaped, so-called medullary or embryonal bodies, and subsequently the lime salts are dissolved by acids or washed away. II. Caries of dentine consists of a dissolution of the lime salts in the intertubular substance by the inflammatory reaction, a melting down of the glue-yielding basis substance (matrix) around and between the canaliculi. The living matter contained in the canaliculi proper is transformed into nucleated protoplasmic bodies, which, together with protoplasmic bodies originating from the living matter in the basis-substance, form the so-called indifferent or inflammatory tissue. III. Caries of cement exhibits first all phenomena known to be present in the early stages of inflammation of bone. The protoplasmic cement-corpuscles, together with the basis-substance, after its liquefaction, produce indifferent or inflammatory elements. IV. The indifferent elements originating through the carious process from enamel, dentine, and cement do not proceed in new formation of living matter, but become disintegrated and transformed into a mass crowded with micrococci and leptothrix. V. Caries of a living tooth, therefore, is an inflammatory process, which, beginning as a chemical process, in turn reduces the tissues of the tooth into embryonic or medullary elements, evidently the same as during the development if the tooth have shared in its formation; and its development and intensity are in direct proportion to the amount of living matter which they contain, as compared with other tissues. VI. The medullary elements, owing to want of nutrition and to continuous irritation, become necrosed, and the seat of a lively new growth of organisms common to all decomposing organic material. VII. Micrococci and leptothrix by no means produce caries; they do not penetrate the cavities in the

basis-substance of the tissues of the tooth, but appear only as secondary formations, owing to the decay of the medullary elements. VIII. In dead and artificial teeth caries is a chemical process, assisted only by the decomposition of the glue-yielding basis-substance of dentine and cement."

Dr. Abbott, therefore, does not consider micro-organisms as the primary cause of caries of the teeth. Dr. Miller, on the other hand, believes that the invasion of micro-organisms is the only cause of dental caries, and that the living tissues are destroyed by the micro-organisms without reacting upon the injury—in other words, without any inflammatory reaction whatsoever in the affected hard tissue of the tooth. Dr. Bödecker, however, believes that the full truth in regard to the carious process can be established only by a combination of both Abbott's and Miller's assertions, and further remarks:—"I admit that micro-organisms are the principal cause of the decay of teeth; but only *dead* material will be destroyed by them without the least reaction. Living tissue—*i. e.*, enamel, dentine, and cementum—invariably react upon the invasion of the micro-organisms by an inflammatory process similar to that in other living tissues in the manner described by Abbott."

Prevention of Caries.—It is an old adage, no less true than trite, that "an ounce of prevention is better than a pound of cure," and in the present instance it may be applied with its full force. Were more attention paid to the practical instruction thus conveyed, many of the diseases of the teeth might be avoided. Most of the remarks that might be made on this subject have been anticipated, consequently it will only be necessary to observe that if the teeth are well formed and well arranged all that will be required is to keep them clean; if any irregularity occurs it should be remedied by the means to be described.

For cleansing the teeth, when they are in a sound condition and free from calcareous deposits, the gums healthy, and the secretions of the mouth normal in character, the regular and frequent use of pure water by means of a proper brush and waxed floss silk will, in most cases, be sufficient. But when the enamel is stained and discolored and the secretions of the mouth inclined to acidity, with a tendency to calcareous deposits, then the employment of a dentifrice is necessary.

Dentifrice—from *dens*, a tooth, and *frico, fricare*, to rub—is a medicinal preparation, in the form of a powder, for cleansing the teeth. An almost numberless variety of dentifrices are in use, and many of them highly injurious. In the preparation of an agent of this kind the object should be to obtain a compound pleasant to the taste, altogether free from acids and acrid substances, and soluble or insoluble,

according to the nature of the case in which it is to be used—one capable of neutralizing and removing acrid and fermenting matters secreted between the teeth and also allaying irritation. A dentifrice, then, should be anti-acid and, moreover, a powder; and the more simple the preparation the better. A preparation composed of orris root, prepared chalk, and pure Castile or white Windsor soap, to which may be added very finely-powdered cuttle-fish bone or pumice-stone, for the removal of calcareous matter when there is a tendency to deposits of this nature, will answer every purpose. When the gums are in a healthy condition there is no use for such ingredients in a dentifrice as Peruvian bark or myrrh, and as for liquid dentifrices, they are of very little use, for the object in using the brush is friction, and as these liquid preparations are generally lubricating alkaline substances, they cause the brush to pass so easily over the teeth as to render them almost useless. In many cases an unhealthy condition of the gums is owing to the irritation produced by local irritants, and their removal is all that is needed to restore them to health. Soap alone will not cleanse the teeth, for it prevents friction; and charcoal, notwithstanding its detergent and antiseptic properties, is injurious as a dentifrice or as an ingredient of one, on account of its insinuating itself under the free margin of the gum and causing it to recede from the neck of the tooth, no matter how finely it may be pulverized. Either of the following dentifrices may be used:—

℞.	Prepared chalk, ...	℥iv.
	Powdered orris root, ...	℥iv.
	Powdered cinnamon, ...	ʒiv.
	Sup. carb. of soda, ...	ʒss.
	White sugar, ...	℥j.
	Oil of lemon, ...	gtt. xv.
	Oil of rose, ...	gtt. ij.
or		
℞.	Prepared chalk, ...	℥ij.
	Powdered orris root, ...	℥ij.
	Pumice stone, ...	℥j.

Ingredients in both prescriptions to be thoroughly pulverized and well mixed.

The importance of keeping the teeth clean cannot be too strongly impressed upon the mind of every individual. Proper attention to the cleanliness of these organs contributes more to their health and preservation than is generally supposed. Against caries it is a most powerful prophylactic. "When the teeth," says Dr. L. S. Parmley, "are kept literally clean, no disease will ever be perceptible. Their structure will equally stand the summer's heat and winter's cold, the changes of climate, the variation of diet, and even the diseases to

which the other parts of the body may be subject from constitutional causes."

The configuration and arrangement of some teeth is such, however, as to preclude the possibility of keeping them clean; but this should not deter any one from using the proper means, for if disease is not wholly prevented they will, at least, contribute very greatly to the preservation of the organs.

The subject of "food in relation to the teeth" has claimed the attention of eminent writers, many of whom are convinced that strict attention on the part of the mother to hygienic laws, from the time of conception, will influence for good the structural quality of the developing tooth-tissues of the child. As phosphate of lime is an important ingredient of the tooth-tissues, it is urged that the requisite quantity of this lime salt should be supplied with the food, and that due attention to the laws of health in regard to exercise, rest, ventilation, bathing, etc., will cause the lime salt to be assimilated and properly appropriated in the formation and development of tooth-tissues. Many also believe that foods prepared by artificial means are very serviceable in supplying such elements as fail to be assimilated in the ordinary manner; hence the use during pregnancy and lactation of preparations of the syrup of the lactophosphate of lime, wheat phosphate, and such articles of diet as oatmeal, cracked wheat, etc., are recommended as being of great benefit. No doubt the amount of phosphate to be used by the system will depend, in a great measure, upon the digestion.

PART THIRD.

DENTAL SURGERY.

Besides the operations of General Surgery which are performed upon the mouth, in common with other parts of the body, Dental Science gives specific directions for those operations of Special Surgery demanded in the—

1. Correction of Irregularities in the Arrangement of the Teeth.
2. Treatment of Dental Caries.
3. Extraction of Teeth.
4. The Use of Anesthetic Agents.
5. Dislocation and Fracture of the Jaw.
6. Diseases of the Maxillary Sinus or Antrum.
7. Caries of the Maxillary Bones.

CHAPTER I.

IRREGULARITY OF THE TEETH—ORTHODONTIA.

Method of Directing Second Dentition.—To properly direct second dentition a knowledge of the relative position of the permanent and temporary teeth at a period soon after the appearance of the first teeth of the permanent set is necessary. Fig. 159 represents the jaws of a child between six and seven years of age, all of the temporary teeth being in position and the six-year molars erupting.

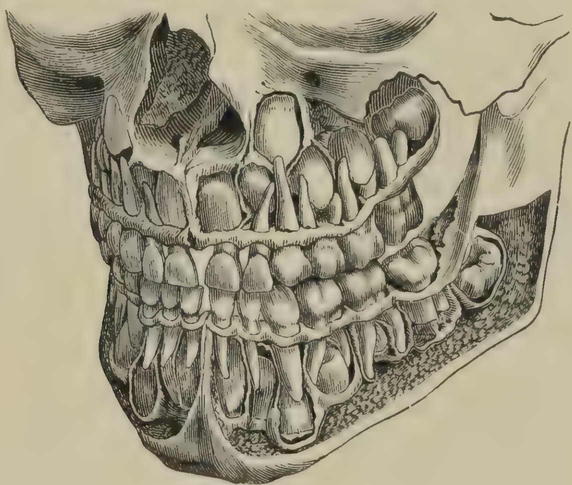


FIG. 159.

The developing crowns of the permanent teeth occupy a higher place than the temporary teeth, and the superior central incisors have a more outward inclination, on account of their size and the increased width of the arch they are to occupy when erupted. The crowns and a small portion only of the roots of these teeth are completed, and they are placed directly under and in contact with the floor of the nares. The superior lateral incisors are not so far advanced in their development as the central incisors, and their crowns are situated beneath the angle of the nares and back of the roots of the temporary laterals and canines.

The canines are situated on a higher plane than either the central

or lateral incisors, not more than one-fourth of an inch below the infra-orbital canals and along the sides of the outer walls of the nares, with their crowns about completed. The crowns of the first and second superior bicuspids are situated on the same plane as the lateral incisors, being embraced by the roots of the first and second temporary molars, and are but partly developed. The crowns of the first permanent molars of both jaws have erupted and are about antagonizing with each other, but their roots are only one-half formed. The crowns of the permanent second molars are but partly developed, and are situated above and posterior to the roots of the first permanent molars, their grinding surfaces having a direction downward and slightly backward toward the lower portion of the external pterygoid processes. The dentes sapientiæ of the upper jaw are represented by small crypts only, in a higher plane in the maxillary tuberosities.

The inferior permanent central incisors are situated directly behind the roots of the temporary incisors, and have their crowns completed with about one-fourth of their roots. The roots of the permanent lateral incisors are not so far developed and are situated somewhat back of the crowns of the permanent central incisors and canines. The permanent central and lateral incisors, as do all of the inferior teeth, occupy a vertical position in the jaws, on account of the inferior dental arch being smaller than the superior. The inferior permanent canines occupy a lower plane than the incisors, and the partly developed roots extend very near to the under surface of the bone of the jaw. The position and stage of development of the inferior permanent bicuspids and first molars are about the same as those of the corresponding teeth of the upper jaw.

The developing crowns of the permanent second molars occupy a higher plane than that of the bicuspids, and their grinding surfaces have a direction upward and forward. The inferior dentes sapientiæ are represented by small crypts only, in the coronoid processes.

There is nothing more destructive to the beauty, health, and durability of the teeth, and no disturbance more easily prevented, than irregularity of their arrangement. Also, in proportion to the deviation of these organs from their proper position in the alveolar arch are the features of the face and the expression of the countenance injured. It also increases the susceptibility of the gums and peridental membrane to morbid impressions.

It is important, therefore, that the mouth, during second dentition, should be properly cared for; and so thoroughly convinced is the author of this, that he does not hesitate to say that if timely precautions were used there would not be one decayed tooth where there are now a dozen.

Much harm, it is true, may be done by improper meddling with the teeth during this period, but this, so far from inducing a total neglect, should only make those having the care of children more solicitous in securing the services of scientific, accomplished practitioners.

For the judicious management of second dentition, much judgment and a correct knowledge of the normal periods of the eruption of the several classes of teeth are required. All unnecessary interference with these organs at this early period of life should certainly be avoided, as it will only tend to mar the perfection at which nature ever aims. The legitimate duty of the physician being, as Mr. Bell correctly observes, "the regulation of the natural functions when deranged," he should never anticipate the removal by nature of the temporary teeth unless their extraction is called for by some pressing emergency, such as a deviation of the permanent ones from their proper place, alveolar abscess, or exfoliation of the alveolar processes.

The mouth should be frequently examined from the time the shedding of the deciduous teeth commences until the completion of second dentition; and when the growth of the permanent teeth so far outstrips the destruction of the roots of the temporary that the former are caused to take an improper direction, such of the latter as have occasioned the obstruction should be immediately removed. In the dentition of the upper front teeth this should never be neglected; for when they come out behind the temporaries, as they most frequently do, and are permitted to advance so far as to fall on the inside of the lower incisors, a permanent obstacle is offered to their subsequent proper adjustment.

When a wrong direction has been given to the growth of the lower front teeth, they are rarely prevented from acquiring their proper arrangement by an obstruction of this sort. They should not, however, on this account be permitted to occupy an erroneous position too long; for the evil will be found easier of correction while recent than after it has continued for a considerable length of time. The irregularity should be immediately removed.

The permanent central incisors of the upper jaw being larger than the temporaries of the same class, it might, therefore, be supposed that the aperture formed by the removal of the one would not be sufficient for the admission of the other without an increase in the size of this part of the maxillary arch. It should be recollected, however, that by the time these teeth usually emerge from the gums, the crowns of the temporary lateral incisors are so much loosened by the partial destruction of their roots as to yield sufficiently to the pressure of the former to permit them to take their proper position within

the dental circle. When this does not happen, the temporary laterals should be extracted.

Under similar circumstances the same course should be pursued with the permanent lateral incisors and the temporary cuspids, and also with the permanent cuspids and the first bicuspids.

But from the fact that the bicuspids are erupted before the permanent cuspids, the premature extraction of the temporary cuspids is often the cause of the projection of one or more of the front teeth; sometimes to such a degree as to produce considerable deformity.

The removal of the temporary cuspids should therefore be avoided when there is reason to believe that the growth of the jaw will provide sufficient space for a deviating permanent lateral incisor to take a proper position within the dental arch.

The bicuspids being situated between the roots of the temporary molars are seldom caused to take an improper direction in their growth. Nor are they often prevented from coming out in their proper place for want of room.

In the management of second dentition much will depend on the experience and judgment of the practitioner. If he be properly informed upon the subject, and gives to it the necessary care and attention, the mouth will in most instances be furnished with a healthful, well arranged, and beautiful set of teeth. At this time "an opportunity," says Mr. Fox, "presents itself for effecting this desirable object" (the prevention of irregularity), "but everything depends upon a correct knowledge of the time when a tooth requires to be extracted, and also of the particular tooth, for often more injury is occasioned by the removal of a tooth too early than if it be left a little too long; because a new tooth which has too much room long before it is required will sometimes take a direction more difficult to alter than a slight irregularity occasioned by an obstruction of short duration."

The temporary teeth by remaining too long are likely to affect the arrangement, and consequently the health, of the permanent teeth, and they should be extracted, because, in that case, their presence is a greater evil than any that would be occasioned by their removal. As a general rule, they should be suffered to remain until their presence is likely to injure the permanent teeth and their contiguous parts.

When the permanent teeth are crowded, the lateral pressure is frequently so great as to fracture the enamel. If this cannot be prevented in any other way, one on each side should be extracted. It is better to sacrifice two than permanently to endanger the health of the whole.

The file or revolving discs and points upon the dental engine should never be used with a view to remedy irregularity; the ex-

traction of two teeth, one on each side of the jaw, however small the space required to be gained may be, is far preferable. The second bicuspids, *cæteris paribus*, should always be removed rather than the first, but sometimes the extraction of the first becomes necessary.

By the removal of the teeth ample room will be gained for the arrangement of all the remaining ones, and the injury resulting from a crowded condition of the organs prevented.

The author does not, however, wish to be understood as conveying the idea that cutting away a portion of the teeth necessarily causes them to decay, for, when the file or disc is used for any other purpose than to gain room, the apertures may be made large enough to prevent the approximation of the organs, and thus the bad effects resulting from the operation will be prevented.

The extraction of the root of a superior front tooth, a central incisor, for example, when the crown has been greatly disfigured or wholly destroyed by mechanical violence, may cause the superior front teeth to fall behind the inferior teeth. Should such a deformity not occur, it frequently happens that an unsightly space is left, too small for the insertion of an artificial tooth to correspond in size with the adjoining natural ones.

To avoid such results the root should be allowed to remain and the proper treatment instituted to subdue the inflammation, the pulp removed when exposed, and the root filled to the apex with gold or other suitable material. By pursuing such a course the root is retained until such a time as its removal will not affect the adjoining teeth. In some cases the portion of the crown destroyed may be restored with gold, or an artificial crown inserted on a pivot.

When the deciduous canines are extracted on the approach of the permanent lateral incisors, the first bicuspids will move forward and occupy the space necessary for the reception of the permanent canines, which may erupt over the laterals, and by their pressure cause these latter teeth to shut within the lower teeth.

Fig. 160 illustrates the mischief attending the premature extraction of the deciduous canines.

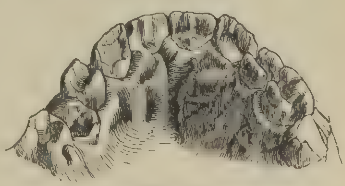


Fig. 160.

Nature, when permitted to proceed with her work without interruption, is able to perform her operations in a perfect and harmonious manner. But the functional operations of all the parts of the body are liable to be disturbed, from an almost innumerable number and variety of causes, and impairment of one organ often gives rise to derangement of the whole organism,

for the relief of which the interposition of art not unfrequently becomes necessary, and it is fortunate for the well-being of man that it can in so many instances be applied with success.

In sound and healthy constitutions the services of the dentist are seldom required to assist or direct second dentition. In remarking upon this subject, Dr. Koecker observes, that "the children for whom the assistance of a dentist is most frequently sought are those who are in delicate, or at least imperfect, constitutional health; in whom the state not only of the temporary teeth, but of the permanent also, is to be considered, and where both are found to be diseased the future health and regularity of the latter require the greatest consideration of the surgeon.

"Irregularity of the teeth is one of their chief predisposing causes of disease, and never fails, even in the most healthy constitutions, to destroy, sooner or later, the strongest and best set of teeth unless properly attended to. It is thus not only a most powerful cause of destruction to the health and beauty of the teeth, but also to the regularity and pleasing symmetry of the features of the face; always producing, though slowly and gradually, some irregularity, and not unfrequently the most surprising and disgusting appearance."

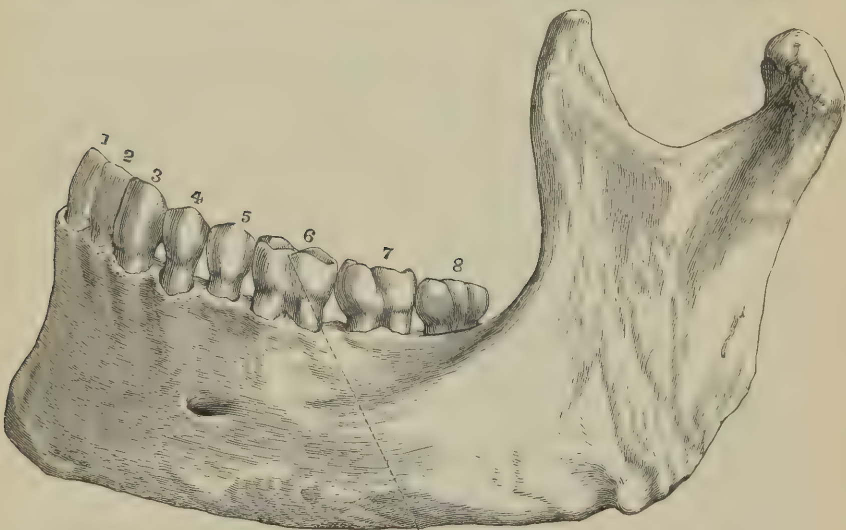
Though nature is generally able to accomplish the task assigned her, yet there are times when she requires aid, and it is then, and then only, that the services of the dentist are needed. Therefore, whilst on the one hand we should guard against any uncalled-for interference, we should on the other always be ready to give such assistance as the nature of the disturbance presented to our notice may require.

The progress of caries in the temporary teeth is very rapid, as a general rule, owing to the large proportion of organic matter compared with the inorganic. Alveolar abscess is, therefore, a common result of the loss of vitality, and the absorption of the alveolar processes from such a cause may expose the apex of the root of one or more temporary teeth.

In the case of the necrosed roots of the superior incisors presenting such a condition, and it is necessary that such teeth should be preserved in order to prevent an irregular arrangement of the succeeding permanent ones, which is very prone to occur from the premature loss of the temporary teeth, the exposed ends of the roots of the necrosed temporary teeth may be excised and carefully rounded off with the file or corundum point. By such a method the necrosed teeth may be retained in the mouth until the period of shedding has arrived, and the space necessary for the reception of the corresponding permanent teeth be preserved.

The eruption of the permanent teeth begins before any of the tem-

porary teeth are shed, the first of the permanent teeth to appear being the sixth-year molars, between five and a half and six and a half years. These teeth are often mistaken for temporary teeth, and being prone to decay, on account of defective structure and the early period of their eruption, they are frequently lost early in life. But as the sixth-year molars perform an important part in the preservation of the integrity of the arch, their retention is desirable if possible. Cases, however, occur where they cannot be permanently preserved, when every effort should be made to preserve them up to a certain period, namely, until the twelfth-year molars are about to erupt, or until a period between the tenth and twelfth years. If the sixth-year molars



SIXTH-YEAR MOLAR.
FIG. 161.

are lost earlier than the period named, the adjoining teeth will close up and cause irregularity when the other teeth appear. On the other hand, if the sixth-year molars are lost later than the time named, the space they occupied is never compactly closed, and the adjacent teeth will incline toward the vacant space, and the continued occlusion in mastication will cause them to tip over to such a degree as to result in a decided impairment of the occlusion. Such irregular teeth may also become painful and loose, on account of the recession of the gums and the absorption of the alveolar processes, and even the adjoining teeth may suffer in a similar manner.

Fig. 161 represents an adult lower jaw, side view.

Irregularity of Arrangement of the Teeth.—The causes of the various

forms of irregularity of the teeth are divided into *accidental*—those occurring after the eruption of the teeth, and *congenital*—those occurring prior to their eruption.

The accidental forms of irregularity are most commonly caused by the presence of temporary teeth beyond the proper time of shedding, owing to the process of absorption of their roots not being commensurate with the development of the permanent teeth, or to the presence of necrosed roots of temporary teeth which are not absorbed. The congenital forms of irregularity are generally caused by a want of development of the jaws commensurate with the size of the teeth. In some rare cases the excessive development of the maxillæ may result in abnormal spaces between the teeth.

The temporary teeth seldom deviate from their proper place in the alveolar arch; but irregularity of arrangement is of frequent occurrence in the permanent teeth, especially the cuspids and incisors. The first and second molars are seldom irregular, for, like the teeth of first dentition, they rarely encounter obstruction in their growth and eruption. The sixth-year molars being the first of the permanent set to appear, the ten anterior teeth are limited to that part of the arch occupied by the ten temporary teeth; if this space is too small, irregularity must of necessity ensue.

The dentes sapientiæ are sometimes irregularly erupted, in consequence of a want of correspondence between the development of the tooth and the growth of the maxilla. The tooth in such cases takes usually the direction of least resistance, the crown presenting more or less obliquely forward, backward, outward, or inward. Of these four positions the first and fourth are found usually in the lower jaw; the second and third are most common in the upper jaw.

When a bicuspid is forced from its proper place it turns inward toward the tongue or outward toward the cheek, accordingly as it is in the upper or lower jaw; or it may be so turned in its cavity by the occlusion of the teeth in the opposite jaw, the loss of an adjoining tooth giving the necessary space, as to present one of its proximate surfaces toward the cheek. The cuspids, when prevented from coming out in their proper place, make their appearance either before or behind the other teeth. When they come out anteriorly, which they do more frequently than posteriorly, they often become a source of annoyance to the upper lip, excoriating and sometimes ulcerating the mucous membrane.

The incisors of the upper jaw present a greater variety of abnormal arrangement than any of the other teeth. The centrals come out sometimes before and sometimes behind the arch; at other times their median sides are turned either directly or obliquely forward toward

the lip. The laterals sometimes appear half an inch behind the arch, looking toward the roof of the mouth; at other times they come out in front of the arch, and at other times, again, they are turned obliquely or transversely across it.

When any of the upper incisors are transversely inclined toward the interior of the mouth, the lower teeth at each occlusion of the jaws shut before them and become an obstacle to their adjustment. This form of irregularity often interferes with the lateral motion of the jaw.

The lower incisors sometimes shut in this manner even when there is no inward deviation of the upper teeth. In this case the irregularity is owing to preternatural elongation of the lower jaw, which arises more frequently from some fault of dentition than from any congenital defect in the jaw itself.

Sometimes the superior maxillary arch is so much contracted, and the front teeth in consequence so prominent, that the upper lip is prevented from covering them. Cases of this kind, however, are rarely met with, but when they do occur it occasions much deformity of the face and forms a species of irregularity very difficult to correct. From the same cause the lateral incisors are sometimes forced from the arch and appear behind the centrals and cuspids, the dental circle being filled with the other teeth.

Fig. 162.

An abnormal prominence of the superior incisors may be either congenital or accidental, and when of the former origin it is almost invariably accompanied with a contracted arch, especially between the bicuspids of the right and left sides of the mouth, the incisors occupying a V-shaped position (Fig. 162).

When this form of irregularity has an accidental origin, it is generally caused by a pernicious habit of thumb, tongue, or artificial nipple-sucking.*

* Such a habit as thumb-sucking may be prevented by the application of some bitter substance, such as aloes, to the thumb, tying the arms close to the body at night, or the wearing of coarse, heavy gloves.

Figs. 163 and 164 represent the form of irregularity caused by thumb-sucking.

An unusual prominence of the superior incisors, attended with a diminution of space between the bicuspids and an abnormally high vaulting of the palate, has been thought by some to be very common to congenital idiots. But Drs. N. W. Kingsley and J. W. White, who examined the inmates of some large institutions for the care of the feeble-minded, found that such a defect is not an invariable rule, as only a small percentage of pronounced irregularity in form of the jaws or arrangement of the teeth, and that generally associated with the lowest type of idiocy, was common to such a class of persons.

FIG. 163.

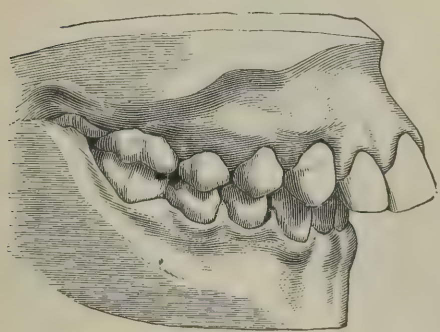


FIG. 164.

Tonsillitis has also been named by Mr. Tomes as a cause for a contracted arch between the opposite bicuspids, the labored breathing from the filling up of the fauces by the enlarged tonsils, with the mouth open, causing increased compression of the cheeks over the lateral parts of the mouth, while the median portion escapes the controlling pressure which would be exercised when the mouth is closed.

Dr. Kingsley is of the opinion that the V-shaped arch is nearly always of congenital origin—that is, an inherited tendency, while the broad or rounded form of arch is often due to mechanical causes.

Inflammation of the throat early in life in children of a strumous diathesis will not only produce deformity of these parts, but irregularity of arrangement of the teeth, by causing tension of the muscles, which has the effect of contracting the oro-naso-pharyngeal space by pressing the lateral portions of the walls inward.

The retention in the jaw of permanent teeth is also a cause of irregularity, as in some cases bicuspids and molars may not erupt sufficiently to meet the opposing teeth.

There are many other deviations in the arrangement of the incisors. Mr. Fox mentions one that was caused by the presence of two supernumerary teeth of a conical form, situated partly behind and partly between the central incisors, which in consequence were thrown forward, while the laterals were placed in a line with the supernumeraries. The central incisors, though half an inch apart, formed one row, and the laterals and supernumeraries another. Mr. Fox says he has seen three cases of this kind. This description of irregularity is rarely met with.

M. Delabarre says that cases of transposition of the germs of the teeth occasionally occur, so that a lateral incisor takes the place of a central, and a central the place of a lateral. A similar transposition of a cuspid and lateral incisor is, also, sometimes seen. Two cases of this sort have fallen under the observation of the author.

The incisors of the lower jaw, being smaller than those of the upper and in other respects less conspicuous, do not so plainly show an irregularity in their arrangement, nor is the appearance of an individual so much affected by it. Still it should be guarded against; for such deviation, whether in the upper or lower jaw, may prove injurious to the health of the teeth and the beauty of the mouth. The growth of the inferior permanent incisors is sometimes more rapid than the destruction of the roots of the corresponding temporaries. In this case the former emerge from the gum behind the latter, and sometimes so far back as greatly to annoy the tongue and interfere with enunciation. At other times the permanent centrals are prevented from assuming their proper place, because the space left for them by the temporaries is not sufficient. The irregularity in the former of these two cases is greater than in the latter. The same causes in like manner affect the laterals.

M. Delabarre mentions a defect in the natural conformation of the jaws, by which the upper temporary incisors on one side of the median line are thrown on the outside of the lower teeth, while the corresponding teeth on the other side of the same line fall within. The same arrangement, he says, may be expected, unless previously remedied, in the permanent teeth. The author has met with but two cases of this sort, and the subjects of these he did not see until after they had reached maturity.

Referring to an ingrafted tendency in all living matter to reproduce itself, Dr. Kingsley remarks: "I am of the opinion that such deformities, even when transmitted for generations, may have the tendency

stamped out by being corrected immediately on their development; that is, before the deformity has made its fixed impression upon the individual."

Mr. Mummery is of the opinion that a large amount of dental disease is originated by overtaxing the brain action of children, and Dr. Kingsley remarks that "the next generation will see more abnormality in dental development and an increase of nervous and cerebral diseases, and that the two are correlated and spring from the same cause.

Treatment of Irregularity.—Orthodontia, or the treatment of irregularity, should accord with the indications of nature. When the irregularity is neither great nor complicated, and its causes are removed before the nineteenth or twentieth year, the teeth, without the aid of art, will in many cases assume the proper position. When, however, the efforts of the economy are unavailing, recourse should be had to the dentist, who can, in most instances, bring the deviating organs to their proper position in the arch. The general rule is, that as soon after the eruption of a tooth as it becomes certain that it will assume an irregular position, interference is justifiable, as every year not only increases the difficulties, but impairs the stability of the dental organs. Teeth incline to return to their places on the removal of the cause of irregularity. They may be also made to change position under the influence of pressure. The pressure must be constant; it must be sufficient to cause motion, yet not so great as to set up destructive inflammation; lastly, it must be continued until the teeth can be kept in place by antagonism with the opposing teeth; or in case there is no such antagonism, a retaining appliance must be worn more or less constantly for a year, or even longer. The regulating appliance should be as simple in its construction as is possible to accomplish the purpose, so that both time and labor may be saved and the patient be able to attend to its removal and adjustment when it becomes necessary to cleanse it; this should frequently be done.

Teeth artificially regulated change position chiefly, if not entirely, by the double process of absorption from one side of the socket, followed by the slower process of ossific deposit on the opposite side. It is therefore essential to success that the tooth be retained in its new position, either by the other teeth or by mechanical appliance, until such deposit is formed. Many cases fail from a want of persistence on the part of patient or dentist.

How far and in what direction a tooth may be removed will depend partly upon the position of the apex of the root, partly upon the antagonism of the opposing teeth.

Cuspids growing out far upon the alveolar arch will usually be found

to have short and curved roots. The attempt to move them might cause the curved apex to pierce the alveolus. Even when not curved, the root is short, and the regulated tooth will not possess that durability which is characteristic of the cuspids. It should always be borne in mind that in regulating the teeth the crown is the movable point, whilst the apex of the root is the fixed point, and must determine in great degree the extent and direction of motion.

Again, the natural or artificial movement of bicuspids backward to make room for front teeth may be aided or hindered by the opposing teeth. An upper bicuspid, for instance, once carried back, so that the posterior slope of the lower bicuspid strikes it, will retain its position or may be thrown even further back.

Upper incisors striking inside the lower, or lower incisors unnaturally prominent, may be regulated, and the opposing teeth will tend to keep them in their corrected position. But it will require long and patient use of the regulating apparatus to keep in place upper incisors which project outward, or lower incisors inclining inward.

In deciding upon the removal or extraction of an irregular tooth, it should not be forgotten that a tooth moved by mechanical appliance, especially if the change in position is considerable, will not prove as durable as if no movement had been necessary. Hence it may sometimes be advisable to extract irregular cuspids in cases where their correction requires much change in their position and that of the bicuspids, and the arch is completely and regularly filled by the remaining teeth.

In a case presented to the late Prof. Austen the superior arch was perfectly regular and closely filled, but both cuspids had come out above the arch. The cuspid roots were normal, and it seemed practicable to bring these teeth down into the places of the first bicuspids. But the four bicuspids were sound, and the first bicuspids gave very much the appearance of the natural arrangement. Hence, as in point of expression there would be no great gain and in point of durability a probable loss, it was not thought advisable to subject the patient to the tedious annoyance of regulation.

In describing the treatment of irregularity we shall notice the means by which some of its principal varieties may be remedied; otherwise, the application of the principles of treatment would not be well understood, since it must be varied to suit each individual case.

As a general rule, the sooner irregularity in the arrangement of the teeth is remedied the better; for the longer a tooth is allowed to occupy a wrong position, the more difficult will be its adjustment. The position of a tooth may sometimes be altered after the eighteenth, twentieth, or even the thirtieth year; but it is better not to delay the

application of the proper means until so late a period. A change of this kind may be much more easily effected before the several parts of the osseous system have reached their full development, and while the formative process is in vigorous operation, than at a later period of life. The age of the subject, therefore, should always govern the practitioner in forming an opinion as to the practicability of correcting irregularity. Previously to the twentieth year the worst varieties of irregularity may in most cases be successfully treated.

The first thing claiming attention in the treatment is the removal of its causes. Whenever, therefore, the presence of any of the temporary teeth has given a false direction to one or more of the permanent, they should, as a general rule, be extracted, and the deviating teeth pressed several times a day with the finger in the direction they are to be moved. This, if the irregularity has been occasioned by the presence of a deciduous tooth, will generally be all that is required.

But when it is the result of narrowness of the jaw, either congenital or acquired, a permanent tooth on either side should be removed to make room for such as are improperly situated. All the teeth being sound and well formed, the second bicuspids are the teeth which should be extracted; but if, as is often the case, the first permanent molars are so much decayed as to render their preservation impracticable, or, at least, doubtful, these teeth should be removed in their stead. After the removal of the second bicuspids, the first, usually, very soon fall back into the places which they occupied, and furnish ample room for the cuspids and incisors. But if they fail to do this, they may be gradually forced back by inserting wedges of wood or rubber between them and the cuspids, or by means of a ligature of silk or rubber securely fastened to the first molar on each side, or by other proper appliances. These should be renewed every day until the desired result is produced.

The most frequent kind of irregularity resulting from narrowness of the jaw is the prominence of the cuspids. These teeth, with the exception of the second and third molars, are the last of the teeth of second dentition to be erupted, consequently they are more liable to be forced out of the arch than any others, especially when it is so much contracted as to be almost entirely filled before they make their appearance. The common practice in such cases was to remove the projecting teeth. But as the cuspids contribute more than any of the other teeth, except the incisors, to the beauty of the mouth, and can in almost every case be brought to their proper place, the practice is injudicious. Instead of removing these, a bicuspid should be extracted from each side. When the space between the lateral incisor and the bicuspid is equal to one-half the width of the crown of the

cuspid the second bicuspid should be removed, but when it is less, the first should be taken out, because, although the crown of the latter may be carried far enough back after the removal of the former to admit the crown of the cuspid between it and the lateral incisor, the root of this tooth will remain in front and partly across the root of the first bicuspid, leaving a more or less prominent vertical ridge on the anterior part of the alveolar border, which, to some extent at least, acts as an irritant to the gums and periosteum.

As the incisors of the upper jaw are more conspicuous than those of the lower, and when well arranged contribute more to the beauty of the mouth, their preservation and regularity are of greater relative importance. Hence, the removal of a lateral incisor, when it is situated behind the dental arch, as is often done with a view to remedy the deformity produced by false position, is a practice which cannot be too strongly deprecated, provided sufficient space can be made for it between the cuspid and central incisor by the removal of a bicuspid from each side of the jaw.

Dr. Kingsley remarks that "cases are of frequent occurrence which show that a pair of any of the teeth in the mouth may be removed to correct an irregularity, excepting the canines of both jaws and the superior central incisors." "It would be an inconceivable case which would justify the extraction of the superior central incisors; but the upper lateral incisors and any pair of the lower incisors may be removed, in certain cases, without any serious detriment to the appearance of the mouth." "It is not necessary to the contour, symmetry, or harmony of the features that every one of the masticating organs should be retained in the mouth." "The *articulation* of masticating organs is of much more importance than their number, and a limited number of grinding teeth fitting closely on occlusion will be of far greater benefit to the individual than a mouthful of teeth with the articulation disturbed." "It is a disputed point as to which of the teeth behind the six front teeth can be best spared from the mouth." "If the sixth-year molars are badly decayed their removal would be indicated. If they were sound, and also the bicuspids, there might be no greater reason for their removal than either of the bicuspids. In fact, sound molars in the jaw are of more value as masticating organs than equally sound bicuspids." The same writer is also of the opinion that extraction of any teeth from a V-shaped jaw before it is widened would be likely to prove bad practice.

Many different forms of appliances are necessary in correcting an irregular arrangement of the teeth, as almost every case presents its own peculiarities. It is therefore not only impossible to describe every form of irregularity to which the teeth are subject, but also the

forms of appliances necessary. The attention of the reader will, therefore, be directed to the treatment of the most common forms and the necessary appliances for their correction, modifications of which can be constructed according to the peculiarities presenting themselves. The most simple appliances for correcting irregularity consist of rings cut from rubber tubing and silk or rubber ligatures, which have their uses in the management of some of the easily manipulated cases. The value of such simple appliances, however, depends upon the skill exercised in applying and securing them. A simple band or ring cut from rubber tubing, and prevented from slipping up to and injuring the gum by means of waxed floss-silk tightly tied about the necks of the teeth, will answer for drawing two teeth, incisors for example, together, between which there is an unsightly space. A similar ring may be employed for correcting an irregular front tooth which projects beyond the arch.

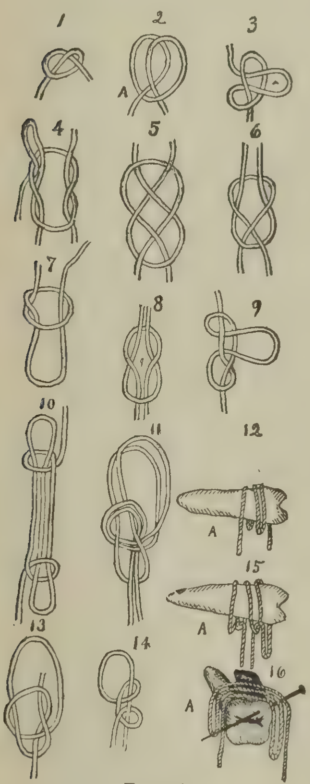


Fig. 165.

The following figures represent some of the most useful knots for applying silk ligatures:—

Fig. 165 represents 13 forms of the most useful knots: 1, thumb-knot; 2 (12, 15, 16), various stages of the clove-hitch; 3, drag-rope, or lever-hitch; 4, draw-knot; 5, garrick bend; 6, common or sheet-bend; 7, running-knot; 9, men's harness-hitch; 10, sheep-shank; 11, double bowline-knot; 12, first stage of clove-hitch; 13, single bow-line-knot; 14, half-hitch; 15, second stage of clove-hitch.

In describing the treatment of irregularity we shall commence with an incisor occupying an oblique or transverse position across the alveolar ridge; so that the cutting edge of the tooth instead of being in a line with the arch forms an angle with it of from forty to ninety degrees. This variety of deviation is rarely met with in both centrals, but often occurs with one. Some dentists have recommended in cases of this kind, when the space between the adjoining central and lateral incisor is equal to the width of the deviating tooth, to turn the latter in its socket with a pair of forceps, or to

extract and immediately replace it in its proper position. It is scarcely necessary to say that if a tooth is turned in its socket, without great care is exercised and the operation gradually performed, the vessels and nerves from which it derives nourishment and vitality are strangulated; hence, though its connection with the alveolus may be partially re-established, it will be liable to act as a morbid irritant and be subject to inflammation from comparatively slight causes.

The tooth, however, may be brought to its proper position, without incurring the risk of injury, by accurately fitting a gold ring or band with knobs on the labial and palatine sides; to each of these a ligature should be attached. Thus fastened to the ring, each end should be carried back, one on either side, in front and behind the arch and secured to the bicuspids, as represented in Fig. 166, so as to act constantly upon the irregular tooth. The ligatures should be renewed from day to day until the tooth assumes its proper position. Should the space not be sufficient to permit the use of the band the method

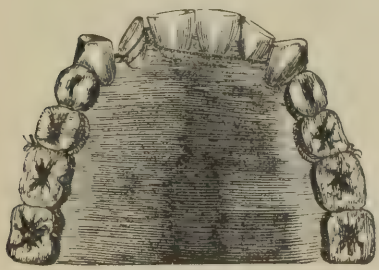


FIG. 166.

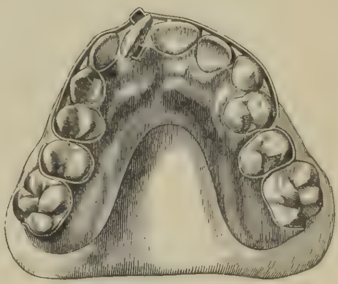


FIG. 167.

practised by Mr. Tomes is shown in Fig. 167. A plate is fitted to the inside of the arch and a band carried in front and soldered to projections from the plate, which pass between the bicuspids. On each side of the irregular tooth a metallic dovetail is fastened and pieces of compressed wood inserted into them. The swelling of the wood gradually turns the tooth. In a few days the metal sockets will require to be changed in position, and in a few weeks the tooth may be thus brought nearly or quite to its natural place.

If the space permits, these two methods may be advantageously combined. Use the plate as in Fig. 167, with the inner dovetail, but for the long outside band substitute the band (Fig. 166) around the tooth, with a loop on the median side; from this pass an elastic ligature to a hook attached to the plate. The tooth is turned on its axis by the combined pull of the ligature and thrust of the wood.

For turning or twisting a tooth upon its axis, Dr. J. F. Flagg re-

commends the clove-hitch, Fig. 165[2], over which the ends of the ligatures are passed and then tied tightly with a surgeon's knot, which holds so firmly to the tooth that it will not slip; the ends are then carried to a rubber ring attached to a neighboring tooth, which by its elasticity keeps up a constant torsion force.

For rotating a single tooth as well as drawing out teeth that incline within the arch, the screws represented in Fig. 168 and designed by Dr. Farrar will be found as useful as any other means.

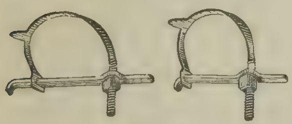


FIG. 168.

Before attempting to turn the deviating organ it should be ascertained if the aperture between the adjoining teeth is sufficient to admit of the operation. If not, it should be increased by the extraction of a bicuspid from each side of the jaw and moving the teeth in front of them backward until sufficient room is obtained. The time required to do this will vary from three to eight or ten weeks, depending upon the number of teeth to be acted on and the age of the patient. A sufficient space may sometimes be gained by pressing outward the adjoining teeth in cases where they fall within the normal curve of the arch. This may be done by the use of the "Coffin Split Plate," or by the "Norton-Talbot Regulating Springs," both of which appliances are described further on.

Fig. 169, 170, and 171 represent favorite devices of Dr. J. N.

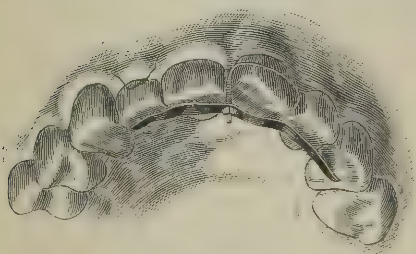


FIG. 169.

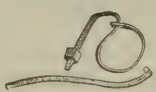


FIG. 170.

FIG. 171.

Farrar for rotating teeth, the simplicity of which requires no further explanation except that it is constructed entirely of gold or platinum, and bound upon the tooth to be rotated by a slip-noose as thin as writing paper and about one-twelfth to one-fifteenth of an inch wide, which is tightened by means of a nut screwed against a small strip of plate resting against other teeth.

Irregular and protruding front teeth may be partially rotated and drawn into position by a very simple, but at the same time ingenious

appliance devised by Dr. S. H. Guilford. Figs. 172, 173, 174, 175, and 176 represent two cases of the kind referred to and Dr. Guilford's

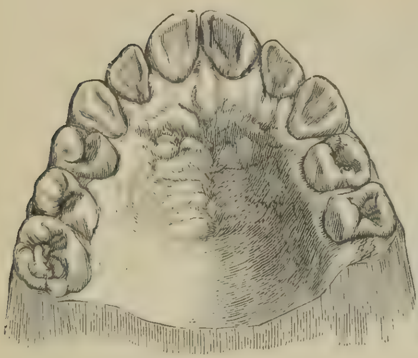


FIG. 172.

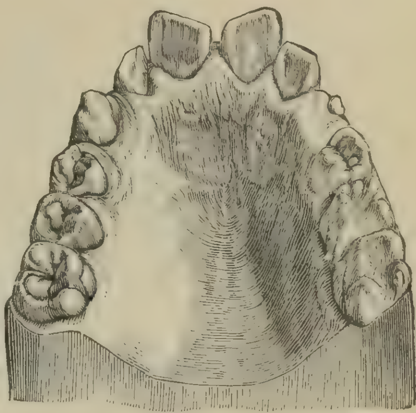


FIG. 173.

appliance. According to Dr. Guilford's description, this appliance is made on a model of the teeth, and is constructed as follows: "A piece of gold backing cut an eighth of an inch wide, and of sufficient length to extend along and a trifle beyond the palatal surfaces of the centrals, is bent to conform as closely as possible to the lingual surfaces of these teeth, and forward so as to slightly clasp the disto-palatal angles as shown in *a*, Fig. 174. To this are soldered two strips cut from upper plate scrap, a little narrower than the first piece, and bent in the form of *b* and *c*, Fig. 174, respectively, which are sufficiently long to extend slightly over the anterior and posterior surfaces of the teeth. After being properly shaped to fit the model, their backs are soldered together, and, in turn, soldered to the part (*a*), as shown in Fig. 174. The only thing then to be done is to reduce with a file the thickness of the part *b*, *c*, which

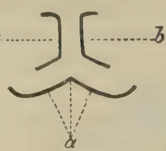


FIG. 174.

FIG. 175.

FIG. 176.

passes between the teeth, Fig. 175. Before applying such a fixture, it may be necessary to place a piece of wood between the teeth for a few hours, to separate them sufficiently to admit the appliance. The labial part of the apparatus should rest against the teeth just at or slightly above the most prominent part of their convexity, while the lingual portion should be near the gum (not quite touching it), and the slightly curved ends of this part will catch just above the little nodule usually found on the disto-palatal angle near the gum. When thus secured it cannot easily be displaced by the action of the lip or tongue. Bend the long palatal arms slightly toward the short labial ones daily, and spring it back into position on the teeth. The elasticity of the gold stiffened by the solder will do the work. To guard against its accidental loosening tie it to the tooth with a thread."

Fig. 177 represents an appliance designed by Dr. Kingsley for twisting the central incisors. After the arch was expanded, as it was a case of contracted arch, a vulcanite plate was required to retain the teeth in their spread condition, and its presence was made available for attachments for elastic ligatures. A small hook of gold wire was inserted opposite the canine teeth, and a little staple or loop of the same wire at the apex of the plate between the centrals. Previous to insertion a ring of rubber cut from tubing was caught over one hook, passed through the loop at the apex and caught on to the other hook. The plate was then introduced into the mouth and the elastic band drawn over each lateral incisor, as seen in the figure. The tendency of the elastic band to contract in a straight line operated only on the inverted corners of the centrals, and by this means the centrals were turned into their proper positions.

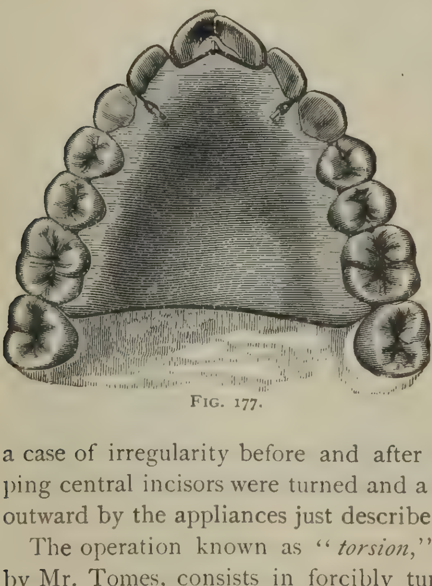


FIG. 177.

Figs. 178 and 179 represent a case of irregularity before and after treatment, where the overlapping central incisors were turned and a deviating lateral incisor forced outward by the appliances just described.

The operation known as "*torsion*," which has been recommended by Mr. Tomes, consists in forcibly turning a tooth in its cavity by grasping it near its neck with a pair of forceps, the beaks of which are

guarded with chamois-skin or other substances, to prevent injury. Where the deviating tooth, such as an incisor, requires but one-fourth of a turn or twist, or less, this is accomplished by one operation; but where one-half turn is required several operations, after intervals of a few days, are necessary. The tooth is then secured in its new position by means of ligatures until a retaining plate is constructed and the necessary antiphlogistic treatment pursued. The danger of such an operation as torsion is the injury likely to occur to the vessels and nerves resulting in devitalization, and in no case should it be attempted until the root of the deviating tooth is fully formed and sufficient space exists for its reception.

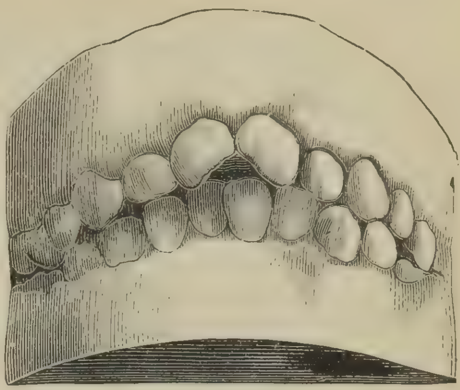


FIG. 178.

The use of vulcanized India-rubber is of great value in the correction of irregularities. The peculiar manipulations it requires will be found in another portion of this work; it is only necessary, therefore, in concluding this chapter, to briefly mention the properties which fit it for this important branch of dental practice.

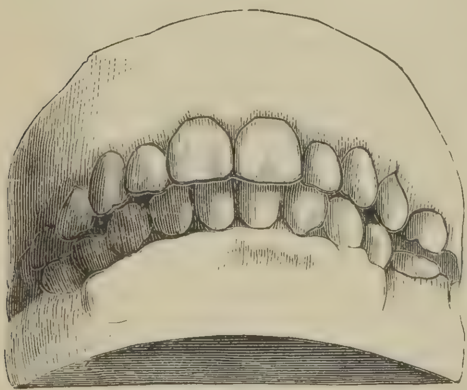


FIG. 179.

It admits of absolutely perfect adaptation to the teeth. If only a part of the crowns of the teeth require fitting, a wax impression will be sufficiently accurate. But if the gum and under-cut surfaces of the teeth are to be fitted, a plaster impression is necessary. Prof. Austen's method of taking plaster impressions in gutta-percha cups will enable a skillful operator to take an accurate impression of any mouth, however irregularly the teeth may be arranged.

A closely-fitting vulcanite plate can be worn with comfort; hence

the patient is not tempted to remove it. It has no motion; hence does not wear the teeth or irritate the gums. Its firmness of adaptation makes it an excellent "fixed point" from which to make pressure or traction in any required direction upon the irregular teeth; the counter-pressure, being distributed all over the regular teeth, is not felt. When it is necessary to cap the molars, a layer of varying thickness should be carried over them all, to prevent the soreness caused by mastication upon any one tooth.

Any variety of appliances may be used in connection with the plate that the judgment of the operator suggests as best adapted to bring about the required change. The plastic nature of the crude material permits enlargement or extension in any direction, without the necessity of soldering, as in metallic plates, and with sufficient exactness.

Thus, prominences may be left behind teeth which are to be moved outward, in which may be made dovetails for the insertion of compressed wood, slits or holes for India-rubber, which makes more rapid pressure than the wood, or holes for the insertion of small screws. These screws may bear directly against the tooth, and be turned slightly each day or two. Or the portion of the plate next the tooth or teeth to be moved may be separated, with a delicate saw, from the plate; the ends of the screw or screws playing into this move the tooth or teeth by a broad bearing, which will, in certain cases, be better than the point of the screw.

Or a small piece of vulcanized rubber may be taken, one end fitting against a molar or bicuspid, and into the other end a screw thread cut to receive a delicate screw; on the head of this screw a second piece of rubber may be fitted against the tooth to be moved, so as to allow the screw to be turned without changing its position on the tooth. This combination forms a miniature jack-screw similar to those recommended some years since by Dr. Dwinelle, and will often be found useful. It may be used in combination with the rubber plate by attaching one end to the plate instead of resting it against a tooth.

If it is desired to move a tooth by the elasticity of a spring, a vulcanite plate is made to fit closely to the mouth and teeth; one end of a metal spring is fitted tightly into a groove cut in the plate, so that the free end shall bear with the requisite force against the tooth. The elastic slip or spring, when made of vulcanized rubber, can readily be bent by means of a warm burnisher, so as to press with greater or less force, as the case may demand. Fig. 180, taken from Mr. Tomes' work, will illustrate one variety of the application of metal springs on a vulcanite plate, in this case pressing outward and laterally the left central and right lateral incisors. This mode of making pressure will

be found very useful. It acts steadily, is under control, and does not need renewal so often as the wedges of wood or rubber. What are known as seamless collars can also be employed for rotating teeth, as follows:—

"To rotate a central incisor, take a fine wire and wrap it around the tooth, close to but not under the gum, and cut the wire so that its ends exactly meet to measure the circumference of the tooth. Straighten the wire without stretching it; find its equal in length on the collar diagram, and select the medium width collar numbered under that line. Take a piece of thick gold plate, shape it like Fig. 181, and solder it to the collar as seen in Fig. 182, using only solder enough to unite the end of the lever, without flowing any solder over the collar to prevent it from fitting close on the tooth. Dry the tooth, smear its neck all around with oxyphosphate cement, and force the collar over

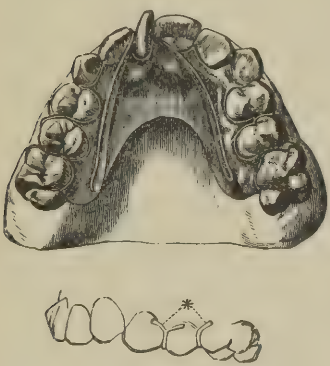


FIG. 180.

FIG. 181.

FIG. 182.

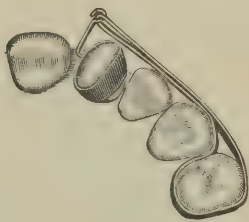


FIG. 183.

the tooth so that the lever will be in position to be pulled by a ligature, or rubber ring, after the cement has become hard, which should take at least ten minutes. The applied fixture is shown by Fig. 183. A bar regulator that is to be anchored to molars or bicuspids may be likewise soldered to collars, which can then be cemented on the anchor teeth; or the bar may be adjustably connected with the collars, which are then fixed by cement on the teeth."

"Such fixed collars also serve as fulcra for jack-screws, the points of which will take on the metal of the collars so as not to slip, and yet leave the enamel uninjured. Other similar functions will be found available in the collars for regulating purposes."

Where ligatures are required, the vulcanite plate affords an easy means of attaching them in any desired position; passing them through holes and tying; looping them over projecting knobs of vul-

canite, or over small metal hooks set in the plate; or stretching them through slits sawn in the plate.

If a band is to be carried for any purpose in front of the arch, it may be connected with the plate on the inside of the arch, through any spaces occurring between the bicuspids or molars; if there are no such spaces, or if they are to be closed up in the process of regulation, the cap which is often required to pass over the molars will connect the two. But the outside band is not often necessary. The inside plate is less awkward to the patient; it is out of sight; and almost, if not quite, every required movement can be obtained from it.

Where the irregularity consists in some of the teeth projecting while others incline inward, such a case can be advantageously treated by the use of a vulcanite plate, the various stages progressing nearly at the same time. The impression in this case to be taken in plaster; the plate capping the second molars; first molars and first bicuspids carried outward by wooden or elastic wedges, or by a double spring of vulcanite fastened to the plate opposite each space of the extracted second bicuspids; the left central and right lateral carried out by wedges or screws; the right central and left lateral brought in by ligatures looped over hooks in the plate. At the completion of the work a new impression to be taken and a plate worn until the teeth become firmly fixed, the use of such a retaining plate preventing a return of the teeth to their old positions.

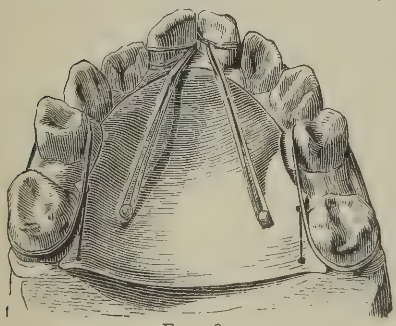


Fig. 184.

Ligatures in connection with a vulcanite plate can also be employed for drawing irregular projecting front teeth to their normal positions, after the removal of posterior teeth (the second right and left bicuspids, for example), to afford the requisite space. Fig. 184 represents a case of torsion and retraction of the central incisors, with pins imbedded in the vulcanite plate for the attachment of the ends of the ligature.

Studs of vulcanized rubber or celluloid, Figs. 185, 186, 187, 188, can be attached to rubber plates for the support of elastic rings, and moved from one position to another, as suggested by Dr. S. J. Shaw.

The late Prof. J. H. McQuillen recommended a strip of thick gold plate, similar to what is used for clasps, and curved to suit the arch, and so applied by means of rubber ligatures or rings as to draw forward irregular teeth. The ends of the bar are screwed to the bicuspid or

molar tooth on either side, and the rubber ligatures or rings pass over the dovetail-shaped parts and the irregular teeth.

FIG. 185.

FIG. 186.

FIG. 187.

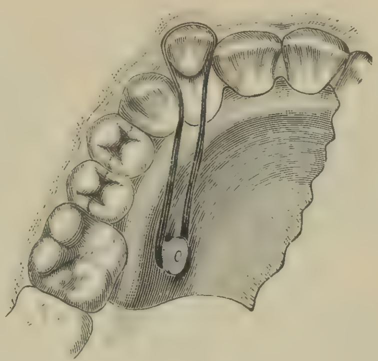


FIG. 188.

Fig. 189 represents portions of metallic bars, *a* and *b*, with holes and slits for elastic ligatures or rings; *c e f*, portions of bars with hooks and prominences for ligatures; *d*, plate, with holes for ligatures (Farrar).

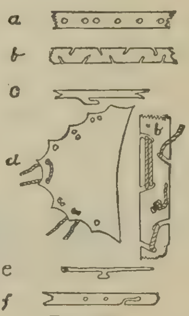


FIG. 189.

Where the irregularity consists in one or more of the superior front teeth shutting within the inferior teeth various appliances have been recommended, the oldest, perhaps, being the grooved plate of Duval, and inclined plane of Catalan, which consisted of a simple circular bar or plate of gold, passing in front of the teeth from the first molar on one side to the first molar on the other, to which the inclined plane was soldered.

In the application of this principle for the correction of irregularity the author has been in the habit of constructing the apparatus somewhat differently. With a metallic die and counter-dies, he has a plate of gold struck up over all the teeth, when practicable, as far back as the first or second molar, completely encasing them and the alveolar ridge. An encasement of this sort (Fig. 190) possesses greater stability than can be obtained for an appliance like the one invented by Catalan. The inclined plane represented by Fig. 190 can be more conveniently constructed of vulcanized rubber, which possesses advantages over metal for such an appliance.

If considerable time is required for the wearing of such an appliance as an inclined plane, injury may result, as the masticating teeth are prone to elongate and the proper articulation of the teeth be

impaired ; again, if the patient refuses to press the deviating teeth, on account of their sensitive condition while moving upon the inclined plane, the result desired will not be accomplished.

FIG. 190.

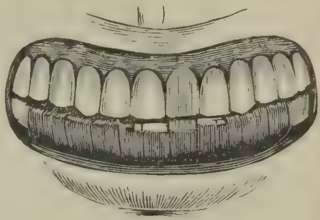


FIG. 191.

In Fig. 192 the letters A and B show a combination of an inclined plane with elastic ligatures, designed by Dr. N. W. Kingsley, to correct an irregularity of both upper and lower incisors, and the same apparatus was used as a retaining plate when the change was completed.

Two things are necessary in the treatment of this form of irregularity; first, to prevent the upper and lower teeth from coming entirely together by placing between them some hard substance, so that the overlapping incisors may not interfere with the necessary outward movement. The second is the application of some

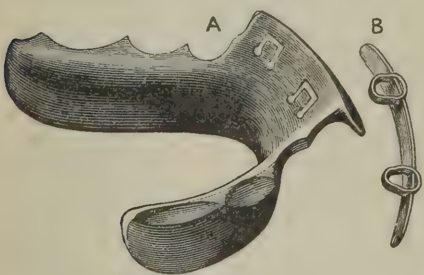


FIG. 192.

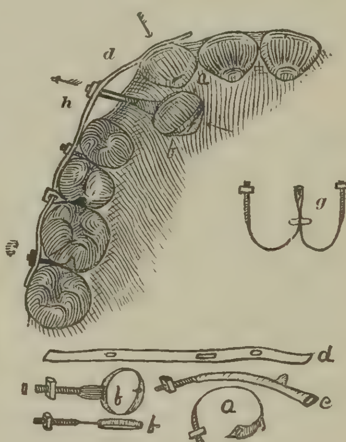


FIG. 193.

fixture that will exert a constant and steady pressure upon the deviating teeth until they pass those of the lower jaw.

Fig. 193 represents another appliance of Dr. Farrar for correcting a form of irregularity where the teeth incline to the inside of the arch. The bar (*d*), in Fig. 193, is made of thick plate, about one-eighth of an inch wide, and is secured at one end (*c*) to a molar or bicuspid (or both) by means of a clamp-band (*a c* or *g*), while the other extremity rests upon a lateral incisor. This forms a bridge of

the bar, which is pierced midway by an oblong hole, through which is passed a flat screw (*b b*), made by filing two sides, which prevents its turning, one end of which is soldered to a thin plate (or it may be hammered thin) at the free extremity of which is soldered a thin band (*b b*), which fits tightly around the crown of the cuspid to be moved. To prevent the band from slipping a metallic pin-point may be soldered on its inside, to fit into a little hole drilled into the tooth (or the band may be attached to the crown by the oxychlorid or oxyphosphate of zinc preparations and no hole drilled into the tooth). A nut (*h*) is then tightened, which draws the cuspid into position and at the same time forces the lateral incisor (which, in the case represented by the cut, is projecting) inward.

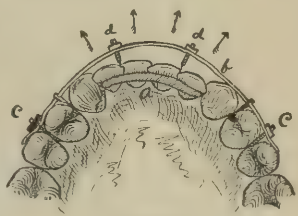


FIG. 194.

Fig. 194 represents another appliance designed by Dr. Farrar for drawing irregular front teeth outward, which needs no explanation.

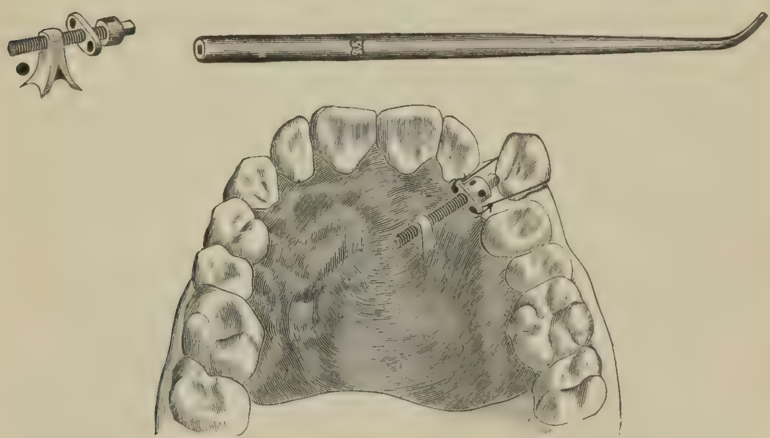


FIG. 195.

For drawing irregular projecting teeth, such as canines, into position, the following appliance of Dr. F. H. Lee, which was designed as an improvement on a somewhat similar appliance designed by Dr. Littig, answers the purpose admirably:—

The Pull-back Jack-screw's special use is for drawing in obstinate canines which have erupted outside of the line of the arch, but it will work with equal satisfaction on any of the other teeth.

The post or nut is set in position and held by vulcanizing into a

rubber plate fitting the mouth as shown in the cut (Fig. 195); the screw-bolt is then placed through the post and a wire or ligature (wire preferred) is passed around the tooth, the ends being secured to the holes in the cross-head or swivel-block. The wire is then tightened from time to time as the tooth is brought to its place. To prevent the plate from being moved out of position by the strain upon it, it should be fastened to the teeth of the arch.

Figs. 196, 197, and 198 represent a form of irregularity consisting of the misplacement of the superior canines and lateral incisors, and the appliance designed by

FIG. 196.

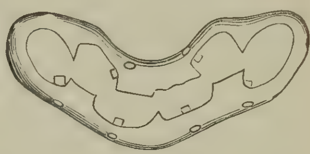


FIG. 197.

Dr. Joseph Richardson for correcting it, the principle of which was suggested a number of years ago by Dr. Redman.

In addition to the malplacement of the lateral incisors and canines there was some lateral contraction of the arch. After the extraction of the first bicuspids a narrow band of vulcanized rubber (Fig. 198) was constructed, embracing the six anterior teeth. Pressure was made upon the misplaced teeth by means of wooden pegs inserted in holes drilled through the band at such points as

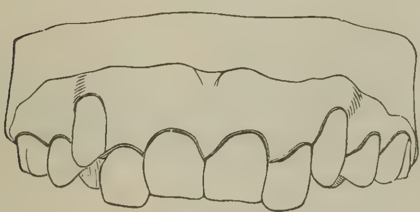


FIG. 198.

were indicated by the direction in which it was desired the teeth should take. The pegs rested against the posterior mesial angles of the lateral incisors in such a way as to force them outward and backward, while those inserted into the opposite or labial portion of the band carried the canines backward and inward. These pegs projected but slightly at first and were lengthened from time to time as the teeth moved.

What is known as the "Lee-Bennett jack-screw" is an appliance suggested by Dr. G. W. Bennett (Fig. 199). It combines a swiveled jack-screw with the forked post-nut of Dr. Lee's Pull-back (Fig. 195), so that any tooth may be pushed outward into line, as shown by the

cut. On occasion both devices may be fixed in the same plate and be simultaneously operated, the Lee to pull back one tooth and the

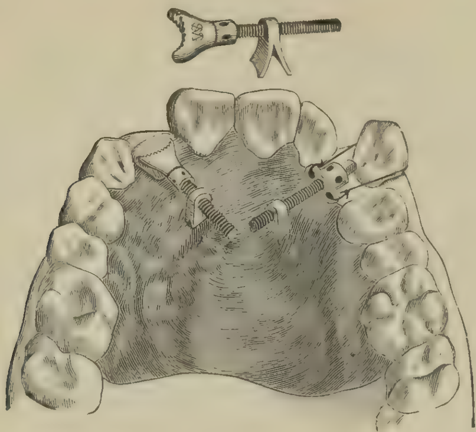


FIG. 199.

Lee-Bennett to push out another. Both of the operating screws may be turned by the same lever.

Figs. 200, 201, 202, represent a simple yet effective appliance suggested by Dr. E. S. Talbot for forcing out a tooth situated inside the arch, and which is described as follows:—

Fig. 200 represents a second inferior bicuspid within the arch, and the appliance, which consists of a thin, narrow, close-fitting vulcanite

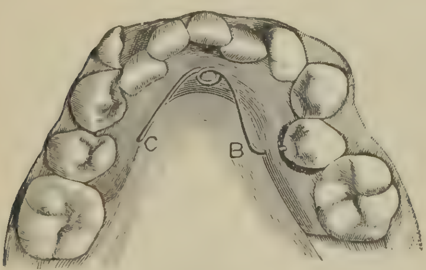


FIG. 200.

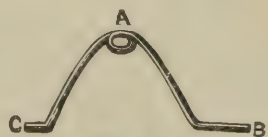


FIG. 201.

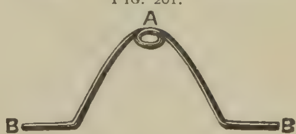


FIG. 202.

plate, with a hole drilled through its middle, opposite the centre of the tooth to be moved. In the other side is another hole, but not drilled quite through the plate. Fig. 201 represents a spring made of piano-wire, having a single coil, *A*, with the ends of its arms bent at a right angle. One of these ends, *C*, is cut short to enter the corresponding hole in the plate, and the other end, *B*, is left long

enough to go through the plate and press upon the lingual surface of the irregular bicuspid, leaving a full eighth of an inch between that arm of the spring and the plate, as is shown in Fig. 200, which represents the spring in position. The plate and spring being separate can be readily removed for cleansing and to increase the power by spreading the arms of the spring. Fig. 202 represents a spring for the same appliance, having two long ends, *B*, *B*, which are designed for a case where two such teeth are to be likewise moved in opposite directions; the two holes in this case to be drilled entirely through the plate, so that the ends of the springs can be made to press against the lingual surfaces of the two deviating teeth.

Dr. Richardson also designed the following appliance, represented by Fig. 203, for shortening teeth elongated during the treatment for irregularity.

It consists of a plate affording fixed points of resistance and having clasps attached and pinned to the centrals with wooden pegs resting against their anterior and the plate

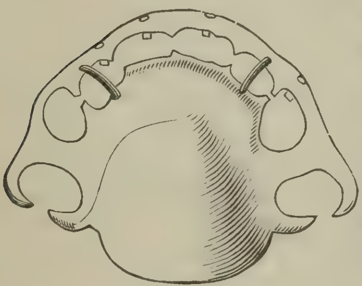


FIG. 203.

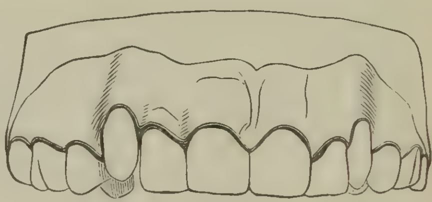


FIG. 204.

against their posterior surfaces, as represented in Fig. 203. To this plate firm elastic cords were attached, stretching across the openings for the elongated teeth. When this plate was pressed firmly to its place upon the teeth and held securely by the means already referred to, the contractile force of the cords produced the necessary shortening of the elongated teeth. Fig. 198 represents the elongated laterals, as shown in Fig. 204, in their proper positions.

A system of regulating teeth, designed by Dr. Jno. J. R. Patrick, is simple and also effectual, and differs from any heretofore referred to. No cast of the mouth is required, and the appliances can be readily cleansed, and may be used for an indefinite number of times. The power employed is the elasticity of a bow-spring (see Fig. 205), which consists of a half-round gold wire and platinum bar (A A), curved to correspond with the shape of the arch, having upon it a number of sliding rings, by means of which anchorage is secured and attachment made to the teeth to be moved. The bar is bent with its flat

surface inward, and is of sufficient length to allow its ends to rest gently on the external lateral surfaces of the first and second molars as desired. The slides are fitted accurately, so as to move steadily. Two of these, which are made longer for the purpose, are used to secure anchorage by soldering to their inner surfaces thin gold bands (B B), previously fitted to the teeth selected. The bar is held in position by set-screws (C C) passing through them. Small buttons are soldered to their external surfaces, through which the screws pass, to give them greater purchase. To the smaller slides the different appliances for moving teeth are attached, as wedges, hooks, V-bars, loops, and bands (D E F G H I), of various sizes and shapes, as required. The apparatus acts as a lever, of which the power is the elasticity of the bow-spring, the fulcrums the points used for anchorage, and the resistance the tooth or teeth to be moved. If these are outside the arch the bow-spring is adjusted so that its flat surface touches all of the projecting

FIG. 205.

teeth, and is firmly set with the set-screws. The wedges are then forced together between the teeth to be moved and the bar; should the wedges cease to act before the teeth are properly placed, the set-screws are loosened, the wedges separated, and the bar taken up until its inner surface is again pressed against the projecting teeth, when it is again set firmly, and the wedges are again brought into play. To move teeth outward the elasticity of the bow-spring is made to draw upon them by means of the proper appliance. Rubber bands or ligatures may be made useful auxiliaries. This appliance can be used on either jaw. Should the bar at any time exhibit a tendency to slip toward the gum, it can be held in place by snapping one of the slides provided with a hook over the cutting edge of a tooth.

What are denominated "Yoke Regulators" are designed for use with Dr. Patrick's appliance. The yokes can be immediately fixed upon the teeth, and the manner of applying them is described as follows:—

The bow is to be passed from behind and between the teeth, however

close together these may be. The coupler is then put over the bow ends, a nut placed in the end of the key and carried to place on the bow. When the nuts have been screwed on, if the bow ends project

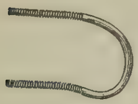


FIG. 206.
MOLAR BOW, A.

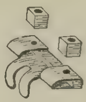


FIG. 207.
MOLAR COUPLER.

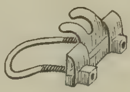


FIG. 208.
MOLAR YOKE.

FIG. 209.
BICUSPID BOW, D

they can be dressed off with a corundum point or be covered by a section of small rubber tubing stretched from nut to nut, or be wound with ligature silk.

FIG. 210.—BICUSPID COUPLER.

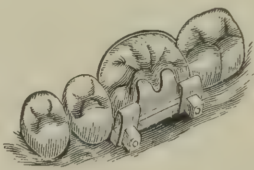


FIG. 211.—MOLAR YOKE IN PLACE AS AN ANCHORAGE FOR A SPRING OR RUBBER RING OR LIGATURE.

Figs. 206, 207, 208, 209, 210, 211, and 212 represent these yokes, bows, couplers, and their application to Patrick's bow-spring.

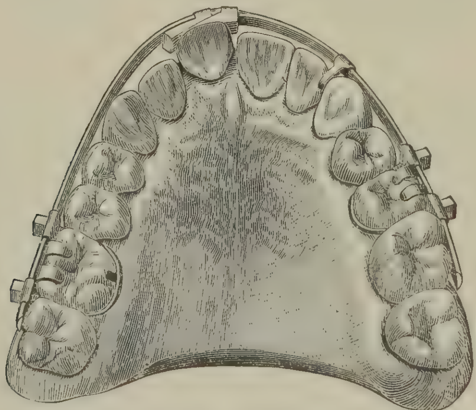


FIG. 212.—MOLAR AND BICUSPID YOKE REGULATORS WITH PATRICK'S BOW-SPRING, WEDGES, AND HOOK IN PLACE.

As comparatively few cases of irregularity occur which in their treatment do not require expansion of the arch, a number of appliances have been designed to accomplish such an object, such as a hinged

metallic plate, the jack-screws, either by direct force or acting on split plates.

One of the most satisfactory appliances, however, for expanding the arch is the invention of Dr. Coffin, of London, Eng., which is represented by Figs. 213, 214. It consists of a thin vulcanite plate capping some or all of the bicuspids and molars and fitting the palatal or lingual surfaces of the anterior teeth, but divided along the median line into two distinct halves, connected, however, by a steel-wire spring, so arranged that, while guiding and limiting the relative motion

FIG. 213.

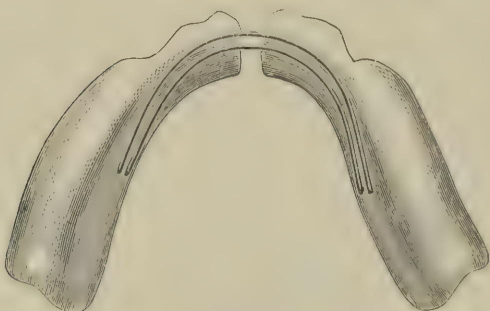


FIG. 214.

Figs. 213 and 214 are typical appliances for the upper and lower jaws. The wire in Fig. 213 shows the form best adapted for expanding the anterior portion of the arch; that in Fig. 214 the form adapted to enlarging the posterior portion. The additional wire on the left of Fig. 213 was used, in the case above mentioned, to force the lateral incisor outward.

of the two halves of the plate, its tension exerted between them may be perfectly varied in direction and magnitude. The impression of the mouth should be obtained with gutta-percha, as it is elastic, and by its slight contraction in cooling affords a tightly-fitting plate, which, however, is not inserted in the mouth until it is divided.

The steel spring is made of pianoforte wire, and is of the form shown in Fig. 215. To construct the spring two pairs of pliers are necessary and a pair of clasp benders. After cutting the proper length of wire, from one to two and a half inches in average cases, the wire being of a diameter between three- and four-hundredths of an

inch (about 0.035 inch), it should be bent first in the centre and then back on each side, with the clasp-benders, holding it with the pliers, and thus giving the spring (as a serviceable form) the shape of a three- or five-curved serpentine figure, like a rounded capital W. It should also be bent to fit as nearly as possible the palatal surface of an upper model or the lingual surface of a lower model, and its ends should be flattened and roughened, without being softened by heat, for half an inch from the extremities. The plate being modeled in wax, the spring is placed on the surface, with its ends buried within, and when removed by the counterpart, protected from the rubber by tin-foil before packing. In making the spring the flattened ends should be coated with tin; some are in the habit of coating over the entire spring, but this is not necessary, as the wire after it is worn becomes discolored with a polished appearance. Some recommend the insertion of a small piece of zinc in contact with each of the ends of the wire, to prevent oxidation. Old pianoforte wire is considered to be the best for these springs. The plate, after being vulcanized, is finished in the usual manner, and is then divided with a fine saw, the edges and corners of the cleft being made round and smooth. It is recommended to have the patient wear the plate in the mouth for a day or two, to first eliminate any causes of irritation not due to its expansive action, before the tension is made by opening the spring. The patient can be instructed to increase the tension from time to time by slightly pulling apart the two halves of the plate and replacing it in the mouth.

FIG. 215.

Figs. 216 and 217 represent modifications of the Coffin plate used

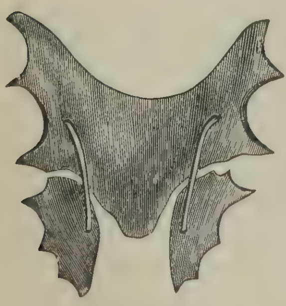


FIG. 216.

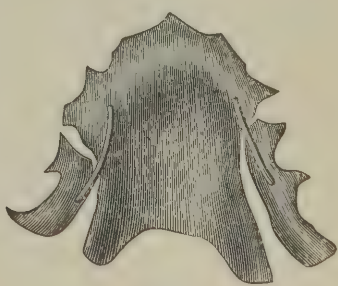


FIG. 217.

for spreading the arch anteriorly and posteriorly, and by which the force is distributed over considerable surface.

Fig. 218 represents a slit plate and springs for pressing outward bicuspids and molars.

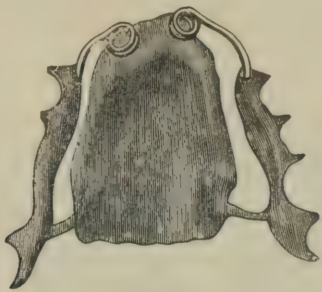


Fig. 218.

Another very satisfactory appliance for expanding either of the dental arches is the Talbot regulating spring, represented by Figs. 219, 220, 221, and 222.

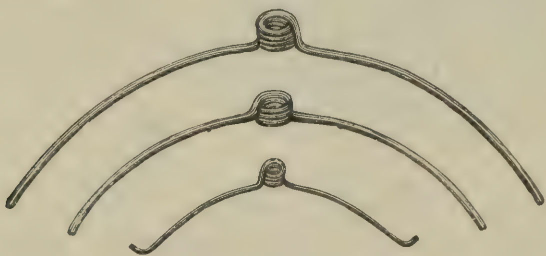


Fig. 219.

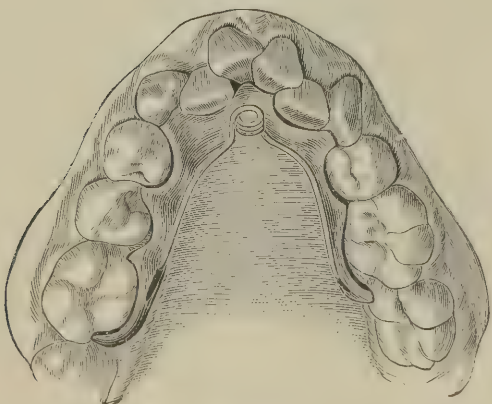


Fig. 220.

On an accurate plaster model of the case to be regulated a thin, narrow vulcanite plate is formed, with a short vertical post fixed,

either before vulcanizing or afterward, by drilling centrally in the plate on the median line. By means of a wheel-bur, grooves or slots are cut in the sides of the plate to receive the ends of the spring and prevent its displacement after the coil has been placed on the post. The tension of the spring can be changed by bending its arms outward or inward. In the other cases grooves may be cut into the anterior and posterior parts of the plate, to correspond with and receive the points *b b* and *c c*, Fig. 222, and holes drilled at these

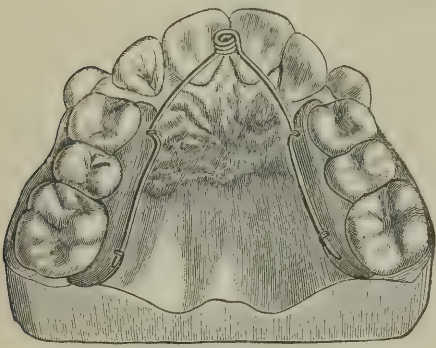


FIG. 221.

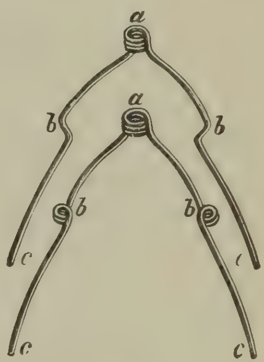


FIG. 222.

points and the wire tied to the rubber plate. To move the anterior teeth with the greatest force the arms can be so adjusted that the pressure exerted is greatest on the anterior parts of the plate. These springs, connected with split-rubber plates, can also be utilized for pressing outward bicuspid and molar teeth. They can also be employed in connection with platinum bands or collars fitted about the necks, to press deviating teeth outward, Figs. 223 and 224. The collars are attached to the teeth by oxyphosphate of zinc, after a hole is drilled in the side of

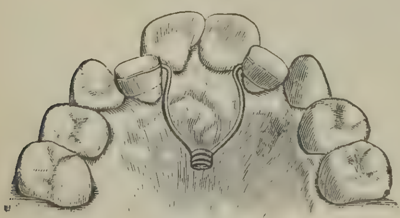


FIG. 223.

FIG. 224.

each, and the spring is bent into form and the ends turned at a sharp angle so as to enter the holes in the collars. These springs can also be used for pressing out the central incisors when they shut within the inferior front teeth. A rubber plate is made to fit the mouth as

shown in Fig. 225, and two of these springs are vulcanized into it at the lateral incisor region. The arms are turned into loops at the extremities to secure a ligature. When the plate is adjusted the arms

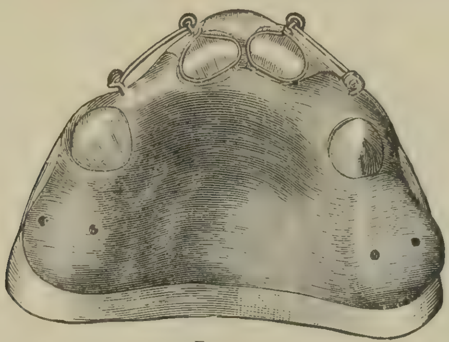


FIG. 225.

are bent horizontally and brought in close proximity to the labial surfaces of the deviating central incisors, and securely tied.

Fig. 226 represents appliances of Dr. Farrar's to move irregular

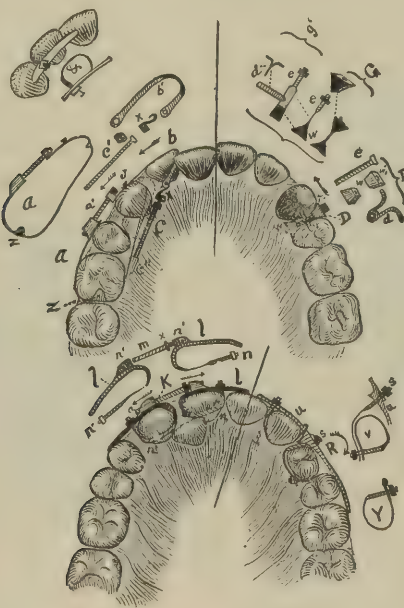


FIG. 226.

teeth—the first to draw teeth together and the second to separate irregular teeth in making space for another.

Fig. 227 represents an appliance, also of Dr. Farrar's, in position for drawing a cuspid toward a second bicuspid, after a first bicuspid has been extracted.

For moving a projecting incisor or cuspid backward, a gold spiral spring was formerly employed. It was found to be more efficient than a ligature of silk, inasmuch as it kept up a constant traction upon the deviating tooth. But it is objectionable on account of the annoyance it causes the patient. A ligature of rubber is far preferable, and this material is now very generally employed in the treatment of every description of irregularity in which simple appliances are required. The difficulty of tying India rubber ligatures is obviated by the use of several sizes of delicate elastic tubing (French manufacture), from which sections may be cut, more or less thick, according to the required length and power of the ligature. Each strip becomes thus an endless band, which may be readily passed from one tooth to another or to a hook on the plate.

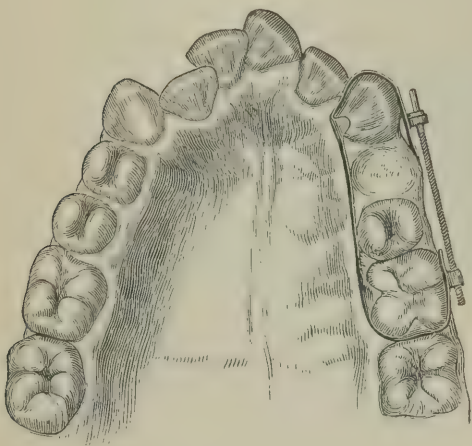


FIG. 227.

Where the superior central incisors project beyond the inferior so much as to give a pointed appearance to the lip, Dr. Kingsley recommends the following regulating appliance (Fig. 228): a rubber plate fitting the roof of the mouth is constructed on a plaster model, taken from a plaster impression, in the same manner as any other vulcanized rubber plate would be made. This plate, which is made as delicate as strength and durability will permit, is cut away opposite the irregular incisors, so that there may be room for these to be pressed

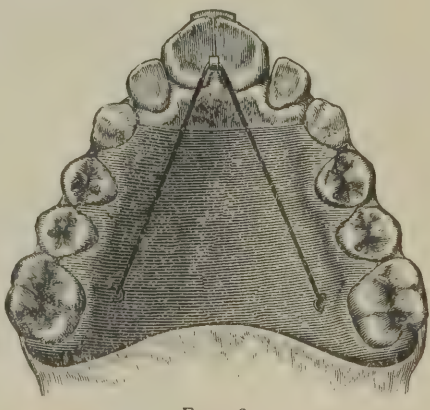


FIG. 228.

in. The pressure, which is brought to bear in such a manner as not only to move these incisors, but act more or less upon the whole arch, is made by means of a very simple contrivance, such as a piece of gold, formed in the shape of a T, about a quarter of an inch in length, and with a staple or ring at the bottom of the upright portion of the T, through which a ligature may be passed. This ligature is a rubber ring, cut from a piece of small rubber tubing, and is passed through the eyelet in the T and then attached to the plate, reaching directly to the second molars on either side.

The plate being introduced into the mouth, the T is brought forward and passed between the central incisors, so that the cross-bar of the T is brought to bear upon their labial surfaces. If the incisors are in close contact, space is made for the gold bar forming the part of the T which projects into the mouth by wedging. The effect of this appliance will be to draw the central incisors inward and at the same time to force the side teeth outward. To prevent the incisors from returning to their abnormal position delicate rubber rings may be used, being slipped over the incisors and attached to a close-fitting retaining plate of rubber covering the roof of the mouth.

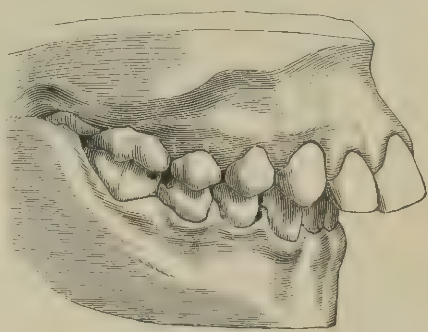


FIG. 229.

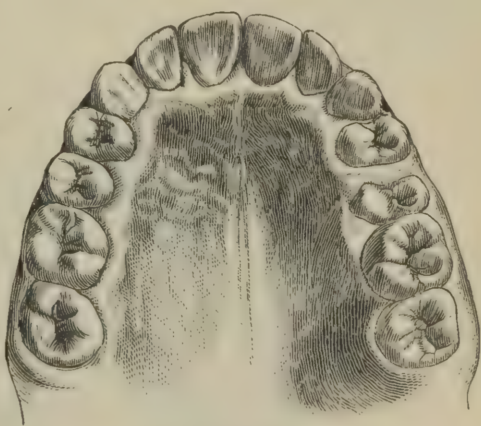


FIG. 230.

Figs. 229 and 230 will represent a case of irregularity before and after treatment, in the treatment of which the appliance above described is applicable.

Fig. 231 represents a similar appliance for correcting a form of irregularity consisting of the projection of the superior front teeth, where the force is applied to all of the projecting teeth at once.

Fig. 232 represents a vulcanite plate, with an alloyed gold and platinum band attached by means of screws suitable for moving back projecting front teeth after the necessary space is obtained by extraction of a bicuspid on each side. This appliance is very effectual and can be regulated by the patient using a common watch-key,

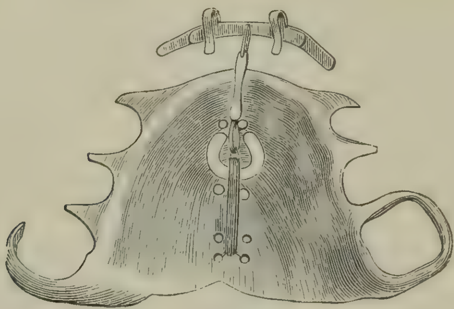


FIG. 231.

or one made for the purpose, in order to increase the pressure of the band upon the projecting teeth. Small hooks attached to the front portion of the band and passing over the cutting edges of the incisors prevent the band from slipping up to the gum.

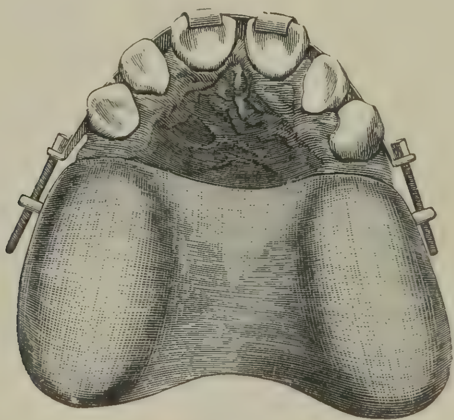


FIG. 232.

Fig. 233 represents a form of special loop for drawing back the canines, and which is attached to the same plate, the band being removed until after these teeth are moved.

A special plate may be constructed for the moving of the canines, or

but one plate be employed, made of the form represented by Fig. 232, and which can be afterward modified, as in Fig. 234.

Dr. B. S. Byrnes has suggested a method of correcting certain forms of irregularities of the teeth by the motive-power of the "spring" or elastic force of thin gold bands, which he described at a meeting of the Southern Dental Association, as follows:—

FIG. 233.

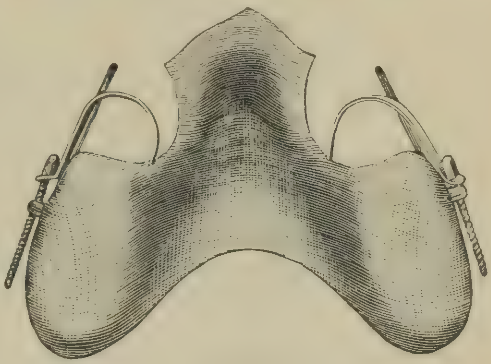


FIG. 234.

"My preference is gold of 20k. to 22k. fine, and, as a rule, the thinner the bands the better the result. It frequently occurs, of course, that for special cases or for a special purpose during the progress of any case the band must be doubled in thickness, but this fact does not change the rule as stated. The pressure exerted by the bands is gentle but constant, and the teeth upon which they operate are moved rapidly, with only the slightest inconvenience to the patient. No plates are used, the fixed points for the application of the motive power being supplied by such of the teeth as are suited to the purpose.

"The method of application is, in a general way, as follows: The fixed points having been determined, the tooth or teeth to be regulated are connected to them by means of a thin gold band. In selecting the fixed points care should be observed to choose teeth which will offer greater resistance to the force to be applied than those which are to be moved will. The band is then manipulated so as to form it into a spring or series of springs, so adjusted as to bear most powerfully on the misplaced tooth. Thus, suppose a projecting superior central incisor is to be drawn inward to align properly with the remainder of the teeth in the arch. A continuous gold band embracing the first molars on both sides is fitted around the outside of the arch. With a dull-pointed instrument like a burnisher the ribbon is then pressed into the interstices of the teeth over which it passes, thus forming it into a series of small springs. The incisor, being the most prominent point, will naturally be most affected by the pressure exerted by the springs, and in a short time it will be found to have moved away from the band so that it is no longer affected by the tension of the springs. As soon as

this occurs the apparatus is removed, the ribbon is annealed, straightened, and a small portion, say a thirty-second to a sixteenth of an inch, as may be required, is cut out of it. The ends are then soldered and the appliance is replaced upon the teeth, the connecting band being formed into a spring as before. Tension is thus kept up until the tooth has assumed the desired position.

"This is the plan of procedure in ordinary, simple cases of irregularity, but the method is equally applicable to more complex conditions. I have not yet seen a case since my adoption of this device where it could not be made to do the work of moving the teeth readily. Sometimes the spring of the band may be advantageously supplemented by other aids, as the insertion of a rubber wedge at points where a particular gain is desired, in accordance with the recognized principle that in regulating teeth the movement is greatest where the elasticity is greatest.

"One of the most important points to observe in the treatment of a case of irregularity is to always have the fixture so tight that it is not necessary to tie it on to the teeth. I frequently apply fixtures by degrees; that is, after making a snug fit, force the appliance partially to place, then allow an interval, sometimes of half an hour, before proceeding to complete the adjustment. I find this plan lessens the severity of the operation to the patient, not only because of the rest afforded, but because the teeth seem more inclined to yield, and thus allow the fixture to be placed more readily.

"To apply the rubber wedge, select a strip of rubber of the desired thickness. Place the gold fixture, which should fit perfectly tight, in position, and insert the rubber behind the band opposite to one of the interstices. Take the ends of the rubber in either hand, stretch it to its fullest extent, and gradually work it to the desired spot; then clip off the ends. Press the teeth forcibly in the direction in which you wish to move them with one hand, while with the burnisher in the other the band is pressed into the interstices.

"Case I.—The first case which I shall describe is that of a young lady who at the time she came to me was in her eighteenth year. The condition of her teeth at that time is well shown in Fig. 235. The missing right superior central had been extracted when the patient was about eleven years old, as the only relief from the unendurable pain following devitalization of the pulp at the hands of an itinerant dentist. To supply the deficiency a partial plate of vulcanite had been worn for the last three and a half years. The remaining anterior teeth of the upper jaw had been gradually forced outward until at the time I first saw them they protruded at an angle of forty-five degrees. In the lower denture the incisors stood within the arch, the cuspids inclin-

ing forward. As a result of this conformation the chin was somewhat wrinkled and slightly upturned. The lips wore a constant pout, the mouth being what may be termed 'peaked.' The molars being the

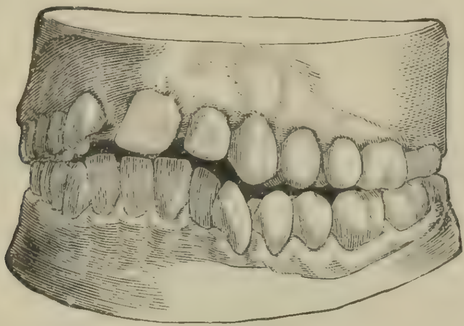


FIG. 235.

only teeth which occluded properly, the mouth was never naturally closed and the patient was unable to make an incisive bite.

"In treating this case I aimed to compass four principal points: 1st, the destruction of the 'peakedness' by producing a broader or more oval arch; 2d, the reduction of the projecting teeth to their proper position; 3d, the improvement of the articulation; and, 4th, the closure of the space caused by the loss of the right superior central.

"The last mentioned was first undertaken. For the first two days a heavy band was used to force the ends or cutting-edges of the right lateral and left central together. A very thin, narrow gold band was then fitted to embrace the necks of these two teeth, and a wedge of wood was inserted under it on the side toward the cutting-edges, causing the teeth to move vertically toward each other. The band being placed around the necks, and the wood spreading it toward the cutting-edges, caused very great pressure at the apex of the root. Another band (Fig. 237) was then constructed to move the incisors backward and bring them into a more vertical position. This was placed in position without removing the first (Fig. 236). It consisted of two bands embracing the cuspids and bicuspids of each side, connected by another band of the same material passing outside of the incisors. The connecting band was then pressed into the interstices between the teeth and rubber wedges were inserted. This fixture caused constant pressure backward on the anterior teeth and an outward pressure on the cuspids and bicuspids. The gold band acted as a lever, the lateral teeth as the fulcrum, and the posterior teeth as the weight to be moved. The connecting band was cut and shortened

FIG. 236.

every other day, the patient having a sitting every day to allow the gold to be sprung more as the teeth moved away from it.

"At the end of three weeks the narrow band at the necks of the incisors was discarded, its work having been accomplished, and that shown in Fig. 237 was substituted by another, which passed around the outside of the whole arch from the first molar on one side to the corresponding tooth on the other. This appliance (Fig. 238) was

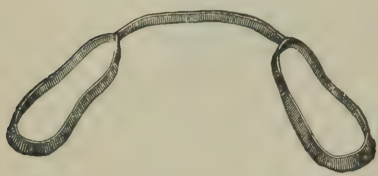


FIG. 237.

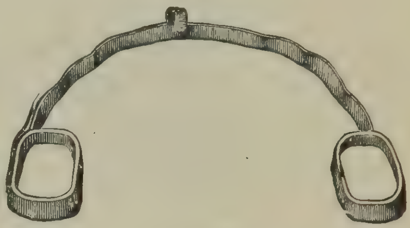


FIG. 238.

required to do little actual work, its principal office being to hold the gain already made and to close the spaces between the teeth, which were now about equal in extent, and to bring the teeth to a vertical position. The gold was doubled in thickness over the incisors and cuspids, to prevent its yielding while the backward movement was progressing, which would allow the arch to again assume the peaked appearance which the treatment was undertaken to correct. The small hook or catch was to prevent the band from slipping up toward the gum, which it showed a tendency to do when first applied. The patient now wears a similarly shaped band, but only one-third as wide, as a retaining piece, which she removes and reapplies at pleasure.

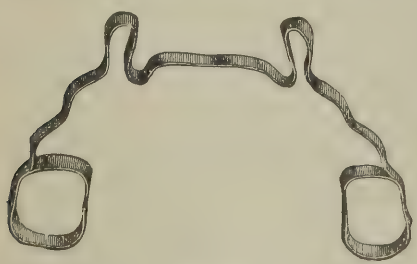


FIG. 239.

"The treatment of the irregu-

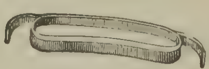


FIG. 240.

larity in the lower anterior teeth was begun about a week after work on the upper jaw was commenced, and was completed in three weeks. A band, constructed as shown in Fig. 239, was applied, clasping the first molars on both sides and passing around the cuspids and behind the incisors. A wooden wedge was placed between the incisors and the band and springs formed by pressing the band into the interstices between the cuspids and bicuspids, cutting and readjusting as before. In

two weeks this fixture was substituted by another (Fig. 240). This was a plain band clasping the incisors, with wings tipping upon the cuspids, and having the portion behind the incisors doubled in thickness. A little block of rubber inserted under each of the wings completed the work in a week's time. The wings were then pressed back to hold the gain, and a piece given to the patient to wear as a retaining plate.

"Fig. 241 is an accurate representation of a cast of the mouth taken at the conclusion of the operation. The correction of the irregularities in this case was accomplished in a month, work being carried forward simultaneously in both jaws after the treatment of the lower teeth was commenced. The work of moving the upper teeth was pushed so rapidly as to slightly 'spring' the maxillary at the attachment of the compressor nasi and the depressor alæ nasi, so that the wings of the nose were pulled laterally inward and downward, causing a slight bulging or bridge on the centre of the nose. But I saw the patient some six months after the case was dismissed, and the muscles had adjusted themselves and no deformity was visible. The patient then informed me that she never had any trouble with either of the retaining fixtures."

FIG. 241.

Figs. 242 and 243 represent an ingenious appliance of Dr. Farrar for laterally moving the apices of the roots as well as the crowns of teeth. It consists of gold clamp-bands operated with a screw; fulcrums are placed between the teeth, to prevent the crowns from moving faster than the entire roots, these fulcrums being replaced by smaller ones as the teeth, under the pressure of the clamp-band, approach each other.

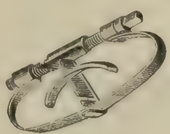


FIG. 242.

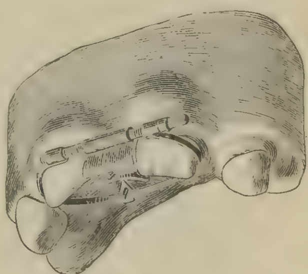


FIG. 243.

Retaining plates are generally required after the operation of moving teeth from irregular to regular positions is completed, for the greatest difficulty in correcting irregularity of the teeth is often caused by the tendency of such teeth to return to their old positions. It is necessary, therefore, that retaining plates should be worn until the corrected teeth become firmly fixed; and no definite time, although the average time may be stated as that of one year, can be given for the completion of such a process. Before permanently removing a retaining plate its use may be dispensed with for a short time, an examination being made daily to determine if there is any tendency of the corrected teeth to return to their irregular positions.

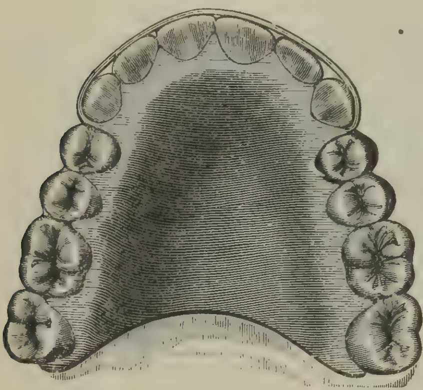


FIG. 244.

A simple form of retaining plate, to be worn after the correction of an irregularity caused by the projection of the superior front teeth, is represented by Fig. 244, which is a simple vulcanite plate with a small gold wire attached to it and passing to the outside of the front teeth through a small opening between the canine and bicuspid teeth on each side. After the correction of a contracted arch a simple vulcanite plate, such as is represented by Fig. 245, will answer as a retaining

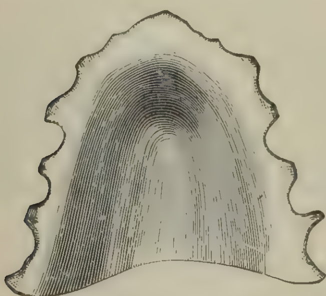


FIG. 245.

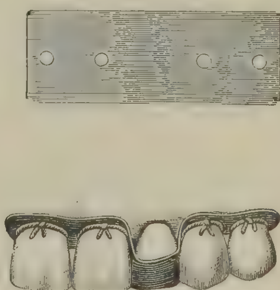


FIG. 246.

plate. A plate of this kind should be adapted to the palatal surfaces of all the superior teeth.

Fig. 246 represents an ingenious application of the rubber dam for the retention of replanted teeth and which may also be utilized for the

retention of one or more irregular teeth after treatment, which is the suggestion of Dr. Herbst. The idea is so plainly shown by the illustrations that further description is unnecessary.

Wedges of elastic rubber are often useful in cases where the lower teeth shut outside the upper ones. They should be used of such a thickness as will exert a gentle pressure only upon the upper teeth.

Fig. 247 represents a case of this kind, with the wedges in position.

FIG. 247.

The jack-screw is also a valuable appliance for regulating teeth. Its use was first suggested by Dr. William H. Dwinelle, and it has been applied alone or in connection with a split-vulcanite plate. Figs. 248 and 249 represent different styles of jack-screws, the old and new,

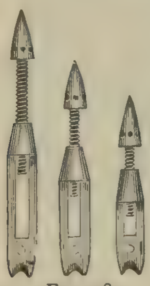


FIG. 248.

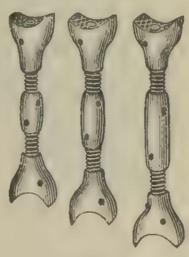


FIG. 249.

which are operated by holes in the middle bar; other holes render them capable of being secured to a tooth, thus avoiding the danger of being swallowed if accidentally detached. In some cases one end of

the first style of screw has been permanently imbedded in the rubber plate.

Dr. M. H. Cryer has designed an appliance by the use of which no injury results to the teeth while the jack-screws are in operation. It consists of thin platinum bands or clasps fitted to the teeth, the ends either soldered or held together by a small screw. The clasp which encircles the tooth to be forced outward contains a small hole for the reception of the point of the jack-screw, and upon the other clasp, which may encircle several teeth used as a fulcrum, small lugs are soldered, between which the other end of the jack-screw, which is of the form of a crotch, fits tightly, and is thus prevented from slipping.

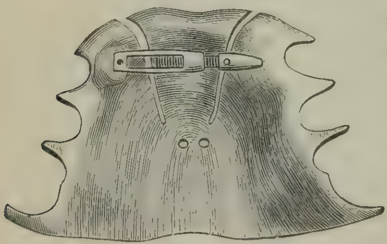


FIG. 250.

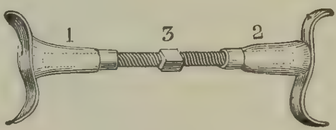


FIG. 251.

Fig. 250 represents a vulcanite split-plate with a jack-screw in position.

Fig. 251 represents a screw which is a combination of the two forms already alluded to, having upon its end a revolving crutch. Levers are also used with advantage on the outside of the arch, to

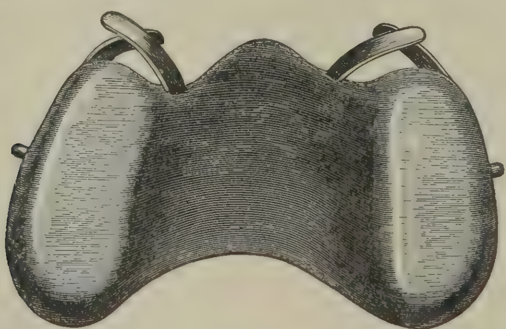


FIG. 252.

press with a gentle force a deviating tooth, and thus move it into a proper position.

Fig. 252 represents a plate of vulcanized rubber with levers or springs attached.

Shortening the teeth has already been referred to in several of the

cases presented, and it remains only to allude to an apparatus designed by Dr. Kingsley for such an object. It consists of a frame of gold adapted to the cutting edges of the incisors and lapping on

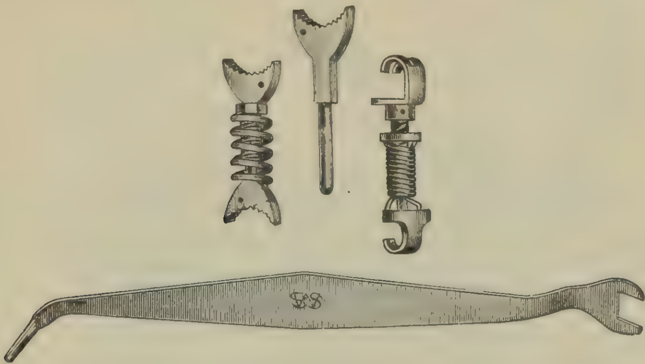


FIG. 253.

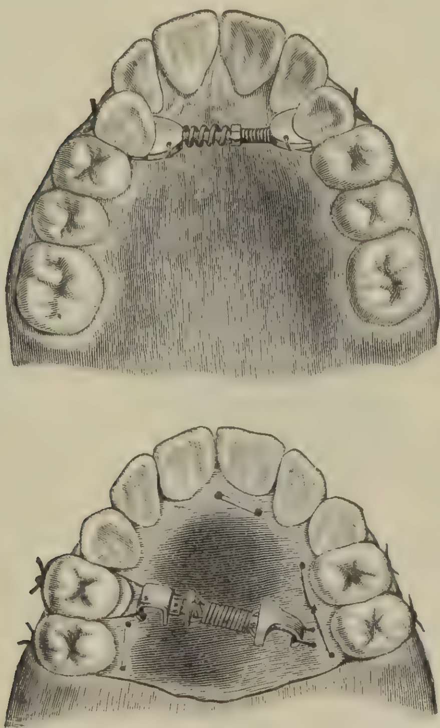


FIG. 254.

Figs. 253 and 254 represent the spring jack-screws of Dr. T. S. Holmes, which combine the pushing and pulling actions.

to the canines, to which is added a stud or post about half an inch in length, soldered to it opposite the canines, and coming out of each corner of the mouth. This apparatus is shown by Fig. 255. The

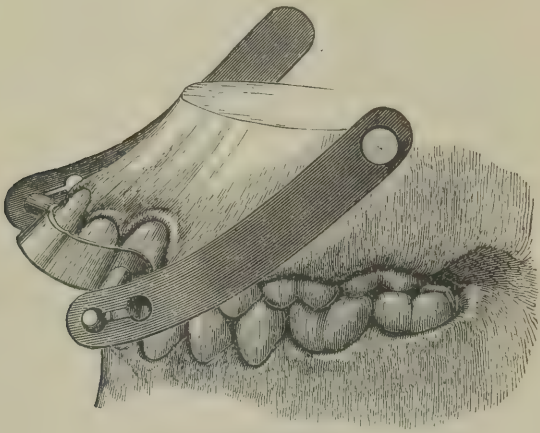


FIG. 255.

arms extend upward, passing outside the cheeks, and consist of metal connected by elastic ligatures to a skull-cap. Fig. 256 represents the entire apparatus in action.

FIG. 256.

For lengthening a short tooth Dr. J. D. White suggests the simple method of tying a thread ligature tightly around the neck of the tooth, under the free margin of the gum, and if much irritation and pain result, to remove the ligature and, keeping the tooth at rest, apply a little pounded ice, in a bag, to the gum. After a week's rest the same treatment is to be pursued every alternate week, until the end is accomplished. But great care is necessary to keep the irritation within proper bounds, this treatment being applicable only to growing teeth, although occasionally to matured teeth also.

The following is an appliance designed by Dr. Farrar to bring into

its proper place in the arch an impacted canine, represented by Fig. 257, which will also prove effectual for elongating a tooth. It consists of a narrow gold plate (see Fig. 258), swaged to fit the palatal margins of the gum and surfaces of the lateral incisors and bicuspids, with thin crossbars, or a clasp around the first bicuspid, connecting this plate with a smaller one adapted to the labial margin of the gum. To the small plate or pad, as it is termed, a smooth nut is soldered, through which passes a screw, its lower end bent so as to enter a small hole drilled into the crown of the short tooth, which, by means of a thread-nut, is forced downward.

FIG. 257.

The elongated tooth is retained in its new position by the delicate apparatus represented by Figs. 259 and 260.

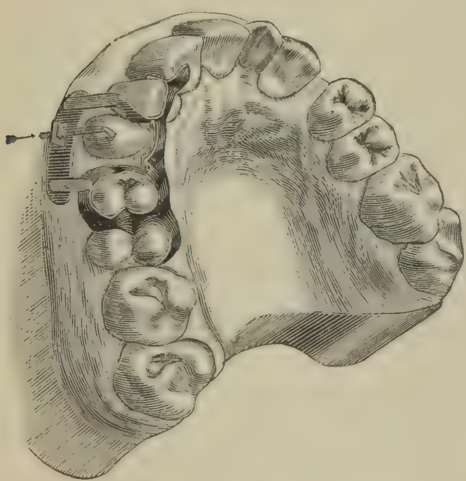


FIG. 258.

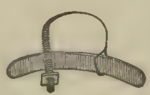


FIG. 259.

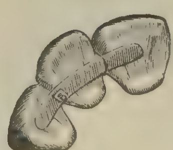


FIG. 260.

The action of an elastic spring, the free end of which acts upon the short tooth while the other is imbedded firmly in a rubber plate, will often answer the purpose of elongating a tooth.

Dr. A. E. Matteson has suggested an appliance to force the eruption of teeth which are impacted in the jaw in such a manner as to prevent their occluding or meeting with the opposite ones when the jaws are closed. It is described as follows: A rubber plate is made to cover the roof of the mouth and to fit the necks of the teeth closely. A French clock spring is adjusted to the rubber plate in such a manner that one end is riveted into the central posterior part, so that when the spring is forced up against the plate its distal end touches the necks of the teeth to be drawn out. Ligatures are then fastened to the necks of the teeth and the spring carried up to the plate and secured to the teeth (Fig. 261). With a sufficiently powerful spring from two to four teeth may be operated upon at one time.

Fig. 262 shows a similar appliance for operating upon impacted lower teeth.

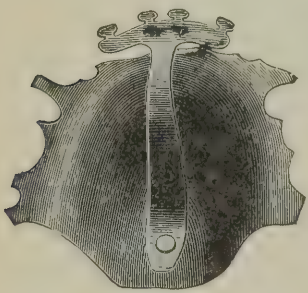


FIG. 261.

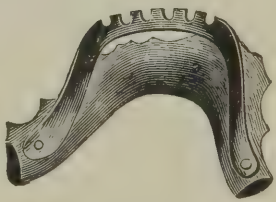


FIG. 262.

For the same purpose, Dr. E. S. Talbot suggests the following appliance: A rubber plate is made to fit the jaw and the teeth, into which a hole is drilled at a point in the center of the space made by the missing or impacted tooth, smaller than the one arm of the coil-wire spring it is to hold. The other arm of the spring, upon the end of which is a loop (Fig. 263), meets the neck of the tooth to be moved, and is there secured with a ligature. When the tooth is so imbedded in the process that a ligature cannot be fastened to it, a platinum band with a hook soldered upon it may be forced up under the gum and secured with oxyphosphate of zinc. If this fails, a hole may be drilled into the crown of the tooth and an eye-bolt fastened in with cement, to which the spring can be secured by means of a ligature. By drilling the hole in the rubber plate at a longer distance from the impacted tooth, a greater spring is given to the wire.

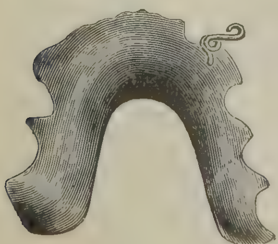


FIG. 263.

Deformity from Excessive Development of the Teeth and Alveolar

Ridge of Lower Jaw.—When the teeth of the lower jaw form a larger arch than those of the upper, the incisors and cuspids of the former shut in front of those of the latter, causing the chin to project, and otherwise impairing the symmetry of the face. Figs. 264 and 265 present a front and a side view of this deformity. It may result from a want of correspondence in the development of the teeth and alveoli of the two maxilla, the upper jaw being defective

FIG. 264.

FIG. 265.

in size, while the lower jaw is natural; or the former being natural, the latter may be in excess. It may also arise from a simple eversion of the lower teeth or inversion of the upper.

Treatment.—The remedial indications of the deformity in question consist in diminishing the size of the dental arch, which is always a tedious and difficult operation, requiring great patience and perseverance on the part of the patient and much mechanical ingenuity and skill on the part of the dentist. The appliances to be employed have of necessity to be more or less complicated, requiring the most perfect accuracy of adaptation and neatness of execution; they must also be worn for a long time, and, as a natural consequence, are a source of considerable annoyance. The first thing to be done is to extract the first inferior bicuspids. Sufficient room will thus be obtained for the contraction which it will be necessary to effect in the dental arch for the accomplishment of the object. An accurate impression of the teeth and alveolar ridge should be taken with wax softened in warm water, and from this impression a plaster model is procured, and afterward a metallic die and counter-die, in the manner to be described in a subsequent chapter.

This done, a gold plate of the ordinary thickness should be swaged to fit the first and second molars (if the second has made its appearance, and if not, the second bicuspid and first molar on each side), so as completely to encase these teeth. If these caps are not thick enough to prevent the front teeth from coming together, a piece of

gold plate may be soldered on that part of each which covers the grinding surfaces of the teeth. Having proceeded thus far, a small gold knob is soldered to the inner and outer front corner of both caps, and to each of these a ligature of silk or rubber is attached. These ligatures are to be brought forward and tied tightly around the cuspids. When thus adjusted the lower arch will present the appearance exhibited in Fig. 266. By this means the cuspids may, in fifteen or twenty days, be taken back to the bicuspids. If in their progress they are not carried toward the inner part of the alveolar ridge, the outer ligatures may be left off after a few days, and the inner ones alone employed to complete the remainder of the operation.

After the positions of the cuspids have been thus changed, a circular bar of gold should be made, extending from one cap to the other, so as to pass about a quarter of an inch behind the incisors, and be soldered to the inner side of each cap. A hole is to be made through this band, behind each of the incisors, through which a ligature of

FIG. 266.

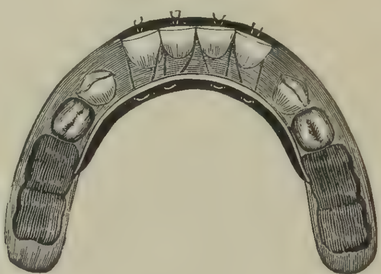


FIG. 267.

silk may be passed and brought forward and tied tightly in front of each tooth. These ligatures should be renewed every day until the teeth are carried far enough back to strike on the inside of the corresponding teeth in the upper jaw.

Fig. 267 represents the appearance which the lower jaw presents with the last-named apparatus upon it, and will better convey an idea of its construction, the manner of its application, and its mode of action, than any description which can be given.

An appliance of this sort may be made to act with great efficiency in remedying the deformity in question; but in its application it is necessary that the caps be fitted with the greatest accuracy to the teeth, and they should be removed every day and thoroughly cleansed, as well as the teeth they cover. If this precaution is neglected, the secretions of the mouth, which collect between the gold caps and teeth, will soon become acid and corrode the latter.

The remarks made in the previous chapter upon the use of the vulcanite are applicable here. Such a plate, for this class of cases, is readily made, and inflicts no injury upon teeth or gums. Elastic instead of silk ligatures might be used, and the retraction of the incisors carried on simultaneously with that of the cuspids. The use of vulcanized rubber instead of gold is of great value in correcting irregularities of this nature, the form of the appliances being the same.

The employment of elastic rubber ligatures in connection with vulcanite plates is generally found to be effectual in correcting the irregularity of the inferior front teeth. The following appliances, from designs of Dr. Kingsley, will be found serviceable:—

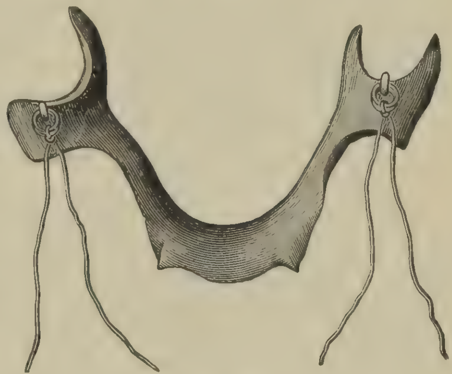


FIG. 268.

Fig. 268 represents an appliance for correcting an irregularity where the inferior canine teeth stand outside the arch, which is somewhat narrow, the first permanent molars being first extracted. Hooks of gold wire are inserted in the plate as points of attachment for the elastic bands, which are drawn forward and attached to the canines by silk or linen threads. By such means the canines were drawn into position and the arch widened.

Fig. 269 represents other forms of attachment for elastic bands and ligatures.

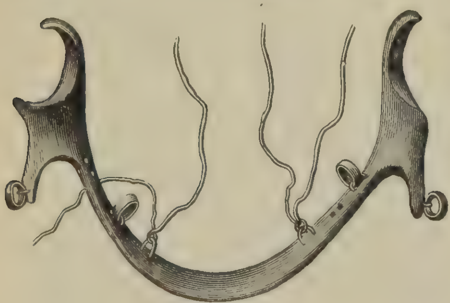


FIG. 269.

FIG. 270.

Fig. 270 shows an appliance for correcting the irregular arrangement of the four inferior incisors. Gold wire hooks (A A) pass over the arch between the canines and adjoining teeth, in order to give an independent attachment for the elastic ligatures outside as well as within the arch, and movements in almost any direction can be obtained.

For cleansing purposes such appliances can be removed and replaced by the patient.

Protrusion of the Lower Jaw.—This deformity, although produced by a different cause from the one last described, is similar to it, and gives to the lower part of the face an unnatural and sometimes disagreeable appearance. It also interferes with mastication, and often with prehension and distinct utterance. It wholly changes the relationship which the teeth should sustain to each other when the mouth is closed. The cusps or protuberances of the bicuspids and molars of one jaw, instead of fitting into the depressions of the corresponding teeth of the other, often strike their most prominent points; at other times the outer protuberances of the lower molars and bicuspids, instead of fitting into the depressions of the same class of teeth in the upper jaw, shut on the outside of these teeth. The trituration of aliments is consequently rendered more or less imperfect.

This protrusion of the lower jaw is supposed by some to be the result of a "natural partial luxation." In fact, its causes are by no means clearly understood. It is often hereditary, and would seem to be caused by that mysterious agency which impresses peculiarities of growth and shape, not only upon the lower maxilla, but upon every bone in the body. The agency is so constant and overruling that we must be prepared to find the jaw returning to its position after the discontinuance of treatment, unless, by the interlocking of the cusps of the upper teeth and the overlapping of the upper incisors, we can restrain the tendency. It is of more frequent occurrence than the one which results from excessive development of the teeth and alveolar ridge, and requires, as before stated, an entirely different plan of treatment. It rarely occurs previously to second dentition.

Treatment.—The plan of treatment formerly adopted consisted in fastening on each side a cap of vulcanite on one of the lower molars, thick enough to keep the front teeth about a quarter of an inch apart when the jaws were closed. Fox's bandage was then applied. This was buckled as tightly as the patient could bear with convenience, pressing the chin upward and backward. A piece of tough wood, slightly hollowed so as to fit the arch of the lower teeth, made narrow at the upper end, was introduced between the teeth several times a day, the concave portion resting upon the outside of the lower and against the inside of the upper, employing at each time as much pressure as could be safely applied. By continuing this operation from day to day, for several weeks, the natural relationship of the jaws would, in most cases, be restored.

The description of bandage here alluded to, and the manner of its

application, is represented in Fig. 271. When the protrusion of the lower jaw is accompanied by irregularity, means should at the same time be employed for remedying it. The earlier the treatment is instituted the more easily will the deformity be overcome. It may, however, be successfully remedied at any time previously to the twentieth year of age, and sometimes at a much later period, but after this time the operation becomes more difficult.

FIG. 271.

An appliance designed by Dr. G. S. Allan (Fig. 272), and which he employed successfully, consists of a brass plate to fit the chin, having arms with hooked ends reaching to a point just below the point of the chin. The arms are arranged in such a way that the distance between them can be altered at will by simply pressing them apart or together. The upper part consists of a simple network going over the head and having two hooks on each side, one hook being above and the other below the ear. The network and the chin-plate are connected by four elastic rubber ligatures exerting pressure in such a manner as to force the lower jaw almost directly backward. The upper elastics are used simply to keep the mouth closed so that the lower elastics will not pull it open, the upper being made just strong enough so that the muscles of the mouth need not be strained to keep the jaw open during the operations of eating and talking.

FIG. 272.

In cases where the lower front teeth close over the upper, and thus cause a deformity of the face, it is important to discriminate correctly

between those which result from malformation and a protrusion of the jaw occasioned by partial luxation, as the remedial indications in the two are entirely different. Those which would prove successful in the one would prove unsuccessful in the other. But, fortunately, deformity arising from the last-mentioned cause is comparatively of rare occurrence; hence, the dentist is seldom called upon to exercise his ingenuity and skill in its treatment.

Dr. Edward H. Angle's system of correcting irregularities of the teeth is described by him as follows:—

"In studying the conditions by which we may best accomplish the movements of the teeth, we may simplify the process if we remember the movements in the line of the arch, which are five: forward, backward, inward, outward, and partial rotation. These and their slight modifications, with the exception of elongation and depression, which are rare, are all we are called on to perform. The principles governing all of these movements are the same. So that, by understanding the principles governing one, we may comprehend all.

"In applying force to a tooth, it should be sufficient to accomplish the movements as rapidly as is consistent with physiological law. When pressure is once applied it should be continued without relinquishment, for there should be no retrogression of the tooth.

"After the mal-posed tooth has been moved into the desired position and proper occlusion secured, it should be firmly supported and retained till it has become firm in its new socket.

"*Appliances.*—The Set No. 1, Fig. 273, consists of the retaining-wire G, and ten sections of retaining and anchor pipes R, R, which will closely slide on wire G. The traction screw A has its smooth end bent for insertion in the short tube D. When the nut is against the A end of the long tube, and that tube soldered to a tooth-band, turning forward the nut will *pull* the hook in the tube D when that has been soldered to a tooth-band; if the nut is against the other end of the long tube, it will *push* D and its tooth-band. B, C is a like but smaller combination, of the same diametric size as the jack-screw J. When the tube of J is soldered to a tooth-band on one tooth, it will *push* directly against a notched tooth-band or a tooth. E is a longer piece of the tube than is shown on J, with which a longer jack-screw may be made when required. The thinner coil of band-material is seen at F, the thicker at H, either of which is sufficient to make about twenty-five tooth-bands. The rotating levers L, three sizes of two each, and wrench W, complete the set, which will suffice for several regulating cases.

"It will thus be seen that the appliances of this set are very simple and few in number, being limited practically to three,—viz.: the lever

for rotating, the screw for pushing, and the traction-screw for pulling; and the other pieces for the purpose of securing attachments. Aside from their advantages of simplicity, efficiency, and cleanliness, their

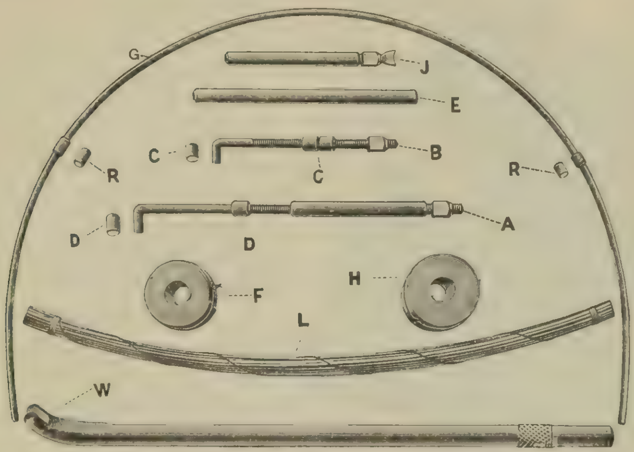


FIG. 273.—SET NO. 1, ANGLE'S APPLIANCES.

intelligent application will effect a stationary anchorage upon, a positive movement of, and afterward a firm retention of, the teeth.

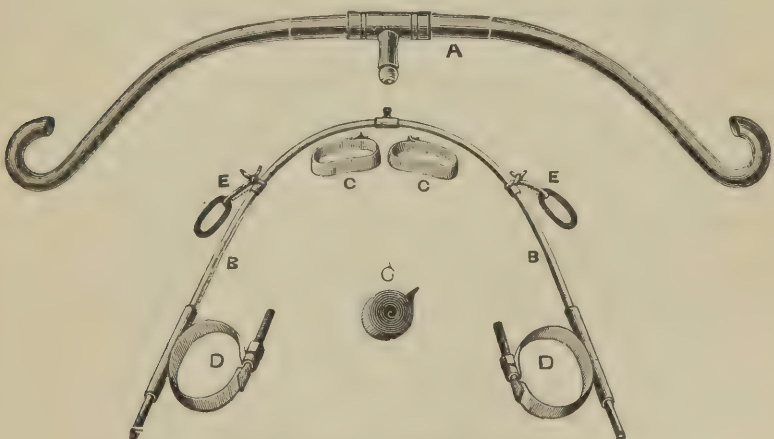


FIG. 274.—SET NO. 2, ANGLE'S APPLIANCES.

"Set No. 2 is designed for the treatment of a special class of irregularities, or that prognathic type known as excessive protrusion of the

upper incisors. The plan of this set (No. 2) differs principally from that of Set No. 1 in that the anchorage is occipital, or by means of a cap covering the back of the head (as seen in Fig. 275), to which heavy elastic bands are attached and received by the hooks upon the ends of traction-bar A. The wire arch B encircles the dental arch and bears against the protruding teeth, receiving the necessary pressure from the standard in the center of the traction-bar. D, D represent adjustable anchor clamp-bands and pipes for securing the ends of the arch B upon the molar teeth, while C, C represent plain bands for holding in position upon the teeth the anterior part of the arch. C is a coil of band-material, from which the bands C, C are to be made for each case. This coil is the same as F, Fig. 273, Set No. 1. E, E represent small rubber rings to retain the teeth during intervals of rest, when not wearing the head-cap and traction-bar.

FIG. 275.

"Fig. 276 shows an extra wire expansion-arch. Its use is directly the opposite that of wire arch B, in that it is used for expanding the

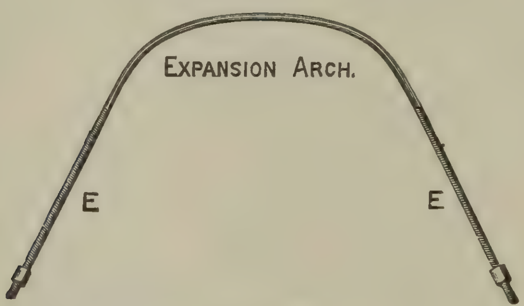


FIG. 276.

arch, and is to be known as the expansion-arch E. The ends of this arch are threaded and provided with nuts. By putting the threaded ends into the anchor-tubes upon the clamp-bands D, Set No. 2, secured to anchor-teeth, the arch may be pushed forward by tightening

the nuts, thus exerting force against other teeth which may have been secured to the arch by means of ligatures or bands.

"In Fig. 277 is shown a metal cap covering the chin, and in connection with the head-gear and heavy elastic bands it is used in the retraction of the inferior maxilla, as shown in the figure. This cap is light, nicely made, highly polished, and will fit all cases, as it is necessary for the fit to be only approximately accurate. A layer of absorbent cotton should always be placed between the metal and the chin while it is being worn.

FIG. 277.

"Fig. 278 represents adjustable clamp-bands for encircling the molars and bicuspids, to which are attached the various appliances. Nos. 3 and 4 have pins soldered to their sides, to which ligatures may be attached. This style of band is especially designed for the treatment of fractures of the maxillæ, and its use, therefore, is fully shown in

FIG. 278.

NO. 1—BICUSPID. NO. 2—MOLAR. NO. 3—BICUSPID. NO. 4—MOLAR.

that portion of this work devoted to such treatment, but it is also useful in the regulation of teeth, as described later.

"The head-cap represented as covering the back of the head (Fig. 277) is also an extra. It is beautifully made and presents a very neat appearance, is strong, durable, and may be quickly adjusted to fit any size of head. As auxiliaries to the above appliances, ligatures made from waxed floss silk, or wire, are necessary.

"*Direction of Forces for Tooth-Movement.*—In the correction of dental irregularities, an appliance must act either by pulling, pushing, or twisting a tooth into proper position; and the movements of the tooth are limited to six: backward or forward in the line of the arch,

outward or inward in the line of the arch, elongation or depression of the tooth in its socket.

"The backward movement of the teeth in the line of the arch is accomplished in two principal ways. First, by the large traction-screw A and D, Set No. 1, shown in Fig. 279, for the retraction of a superior cuspid. The first molar is encircled by a No. 2 clamp-band (Fig. 278), to which is soldered the long sheath of the traction-screw A, Fig. 273. The cuspid is also encircled by a band, having the short tube D, Set No. 1, soldered horizontally to it on its distal surface, with which tube the smooth bent end of the traction-screw engages. The nut, operating against the distal end of the tube, will move the cuspid backward into position. The easiest way to adjust this appliance is to first cement the band upon the cuspid; after the cement has become thoroughly set, the angle of the traction-screw is hooked into the short tube, and the adjustable band latched over the molar. It is very important that the bent end be passed into the tube its *full length,* otherwise it will be broken when force is exerted. The screw may be employed on the outside of the arch; the short tube, in that event, should be attached to the mesio-buccal angle of the band, as shown on the right cuspid of Fig. 280.

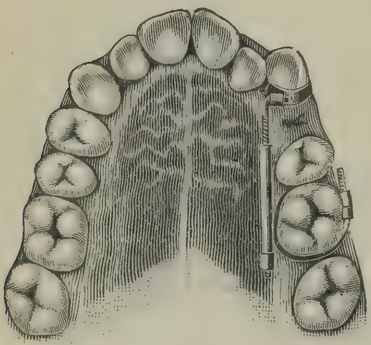


FIG. 279.—RETRACTION OF CUSPID.

"If a movement of rotation as well as retraction is desirable, the angle of the screw should be hooked over a spur, as shown on the left cuspid of Fig. 280, thus concentrating all the force upon one side of the moving tooth. Recent experience has shown that a staple made from the wire G, Set No. 1, is stronger and better than the spur for making this attachment. Should the cuspid be very prominent, requiring the movement to be inward as well as backward, that may be accomplished at the same

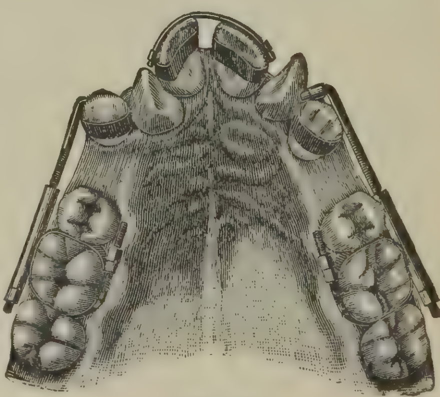


FIG. 280.

time by bending the screw, which, as the nut is turned, will be gradually straightened. (See Fig. 281.)

"A method of reinforcing the anchor-tooth is also shown in this engraving, by enlisting the resistance of the lateral incisor. This tooth is banded and provided with one of the pipes R, Set No. 1, soldered to its distal angle; one end of a piece of the wire G, Set

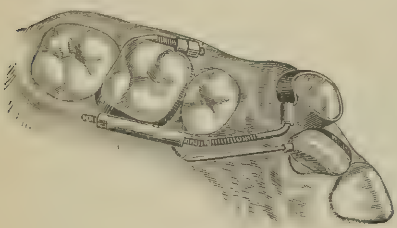


FIG. 281.

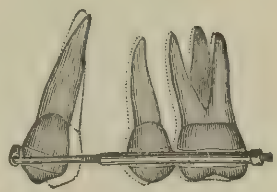


FIG. 282.—STATIONARY ANCHORAGE.

No. 1, is soldered to the sheath of the traction-screw and made to rest in this pipe.

"In making the attachments for retraction after the manner described, it is of the utmost importance that the band encircling the molars should be tightly clamped, burnished, and firmly cemented, so that the attachment will be perfectly rigid. In this way the resistance of the anchorage will be greatly increased, and tipping of the anchor-teeth will be prevented; while if moved at all, they must be dragged bodily through the alveolus, because the apices of the roots move equally with the crown, as shown in Fig. 282, which represents a side view of the appliance in position, the dotted lines showing the movements which must take place if the attachment is properly made. This is a most perfect form of anchorage, and I am indebted to Dr. W. C. Barrett for first suggesting it.

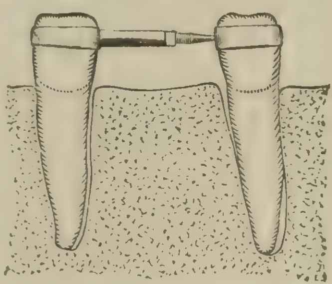


FIG. 283.

"If the nut is placed upon the screw in front of the sheath and tightened, force with the same resistance of anchorage may be exerted in moving the tooth forward instead of backward. When the jack-screw is employed for pushing, the same firmness of anchorage may be gained by soldering the base of the sheath to the anchor-band, which is to be firmly clamped and cemented in position upon the anchor-tooth, as shown in Fig. 283.

"Another way of moving teeth backward in the line of the arch is

by means of Set No. 2, and will be described in the treatment of cases of excessive protrusion of the superior incisors.

"The movement of a tooth forward in the line of the arch may be accomplished by means of the traction-screw, in the same way as already described for retraction, by selecting anchor-teeth on the opposite side to be used in overcoming the resistance of the tooth that is being moved, as shown in Fig. 284, which represents a case in practice, and shows the screw employed in pulling both incisors forward in the line of the arch to close the wide space between the centrals; at the same time providing space for the cuspid, which is being moved out of inlock by means of the jack-screw. In this case the traction-screw was beaten flat, polished, and bent to conform to the curve of the arch.

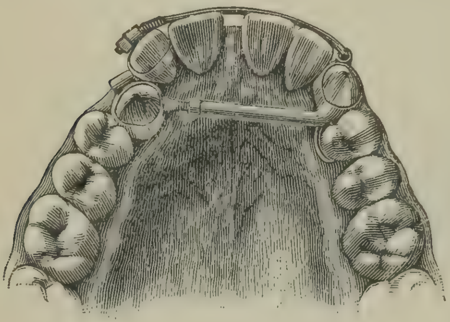


FIG. 284.

"The movement of a tooth from within outward into the line of the arch is accomplished in four principal ways: first, by means of the jack-screw E and J, Set No. 1, the sheath of which is secured to a suitable anchor-tooth, the point acting upon the moving tooth by turning the nut. The base of the sheath of the jack-screw may be secured in various ways, as shown in Fig. 285: first, by a dowel made by soft-soldering a piece of the wire G, Set No. 1, into the end of the sheath which rests in a pit in the anchor-tooth, as in A; by a spur made from the same wire soldered to the anchor-band, over which the end of the sheath is slipped, as in B; by a dowel made from the same wire, slipped into one of the pipes R, Set No. 1, soldered to the anchor-band, as in C (in this way the length of the sheath may also be increased); by pointing the end of the sheath with a file and letting the point rest in the pipe on the anchor-band, as in D; by soldering the sheath directly to the anchor-band, as in E and F; by notching the end of the sheath, which shall engage the anchor-wire as in G, Fig. 285; by soldering the end of the sheath directly to another sheath, as in H; by means of a spur made from the wire G, Set No. 1, soldered to the sheath which shall engage one of the pipes R, Set No. 1, soldered to the anchor-band, as in I; by slipping the end of the sheath over the screw upon the clamp-band, as in J. Of these various ways I prefer that of attaching the sheath directly to the

anchor-band, as in E and F, or by means of the spur, as in B (the spur being quickly and easily made by soldering), by holding a long piece of the wire G, Set No. 1, between two of the fingers of one hand, while the end of the screw upon the clamp-band is grasped between the thumb and finger of the other hand, carrying it in contact with the fine point of the flame, presenting the appearance after soldering

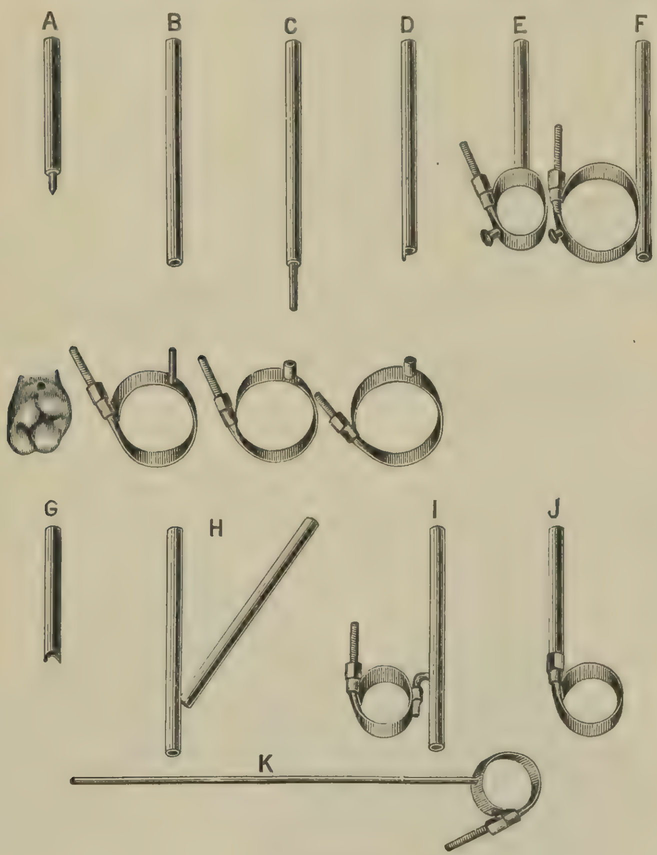


FIG. 285.

shown in K, Fig. 285, after which the wire is cut off, leaving the desired length of the spur.

"The point of the screw is held firmly in position by six principal ways, as shown in Fig. 286. First: By notching the point of the screw with a separating file, which notch will engage a similar notch in the united ends of the band, as in A; by pointing the end of the screw to engage one of the small pipes R, Set No. 1, soldered to the band as

in B ; by a mortise in the band to engage the point of the screw, as in C ; by soldering an elliptical ring (formed by bending the wire G, Set No. 1, as at G, Fig. 286), in which to rest the point of the screw, as in D ; by a staple, made from the same wire, soldered (see H) to the band,

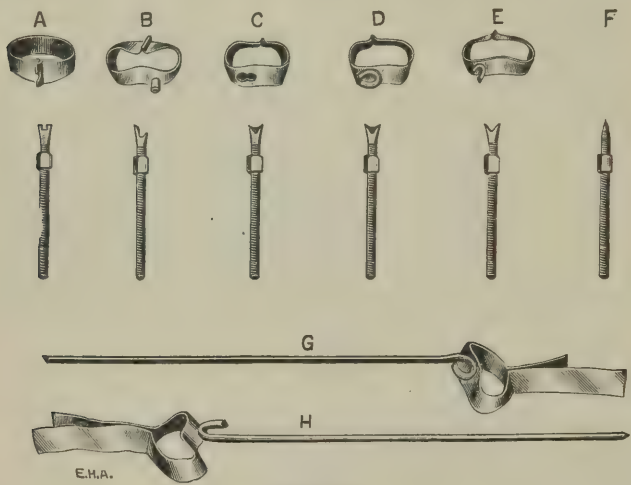


FIG 286.

as in E, the point of the screw being suitably notched ; by pointing the screw to be received in the pit formed in the enamel or filling, as in F. Of these various ways of securing the point of a jack-screw, I prefer the plan shown in D and E, forming the ring and staple upon the ends of long pieces of the wire, which serve as handles while soldering, as in G and H, after which the superfluous portions are clipped off. The roughened ends are then rounded and made smooth with a fine file.

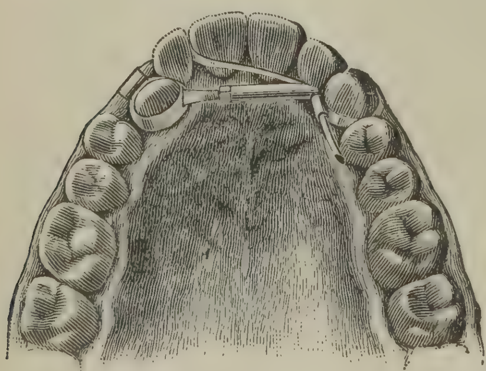


FIG. 287.

"Fig. 287 shows an inlocked cuspid being moved outward, the point of the screw resting in a mortise formed in the band upon the moving tooth, the base of the sheath being notched to engage a piece of the anchor-wire G, Set No. 1, passing through a tube soldered to the lingual surface of the

left cuspid. The anchorage is greatly reinforced by means of this wire, which is beaten flat where it passes between the central and lateral, the end being bent around the labial surface of the central. Force is obtained by turning the nut. After a tooth has been moved into the desired position, it is retained by a piece of the wire G, Set No. 1, passed through a pipe R, Set No. 1, soldered to the band, the wire ends resting upon the labial surfaces of the lateral incisor and first bicuspid. This wire is held in place by a very delicate pin passing through the pipe and one side of the wire, as in Fig. 288.

"Fig. 289 shows a favorite method of reinforcing the anchorage. In this case the sheath of the jack screw was placed on a spur soldered to a bicuspid clamp-band, as at B, Fig. 285. The point of the screw was sharpened and rested in a pit formed in the enamel. Reinforcement was gained by hooking a piece of the wire G, Set No. 1, into two pipes (R, Set No. 1), one soldered to the sheath of the jack-screw near its base, the other soldered to the lingual surface of a lateral incisor band. If the appliance has been carefully adjusted the patient may be provided with a wrench, and instructed in turning the nuts at proper intervals.

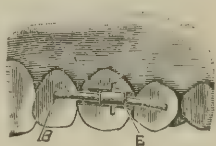


FIG. 288.

"Recent experience has proven that an easier way of attaching the reinforcement wire is to omit the pipe attached to the band on the lateral, soldering the straight end of the wire directly to the band. The other end of the wire should be passed through the pipe, on the sheath, and secured by bending the end around the pipe end.

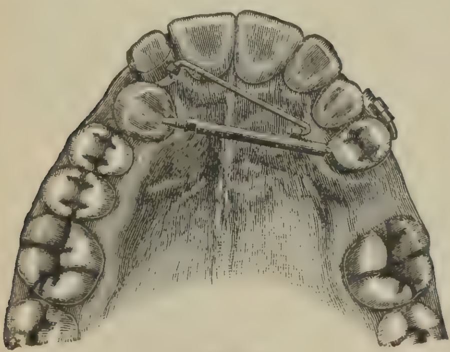


FIG. 289.

"Fig. 290 shows a left lateral being moved outward, reinforcement having been gained in the manner already described, using two pieces of wire attached to bands on the central and cuspid. Not only was the anchorage reinforced, but the incisor and cuspid were prevented from being pushed out, the moving tooth providing space for itself by forcing the adjoining teeth laterally. By this means the most perfect form of anchorage is secured, employing, preferably, the method of attaching the reinforcement wires described in the last case.

"The second mode of moving a tooth from within outward is shown in Fig. 290, where a right lateral is being forced outward by means of the small traction-screws B and C, Set No. 1. A strip of the band-material (F, Set No. 1) is looped around the lateral, the ends resting upon the labial surfaces of the adjoining teeth. On one end is soldered a short tube, C (accompanying the screw), attached vertically, while on the other end a similar tube is attached horizontally. Into these tubes the traction-screw B, Set No. 1, is placed, being bent to conform to the circle of the arch, and used, in this case, to push instead of pull. This appliance should be frequently tightened by turning the nut, or it will become loose and cause trouble. The parts of this device are shown separately in Fig. 291.

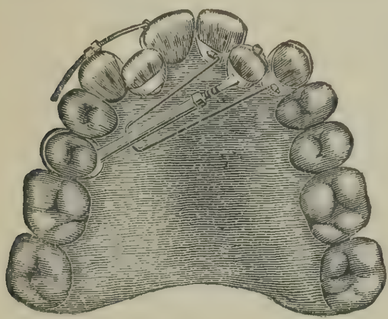


FIG. 290.

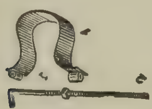


FIG. 291.

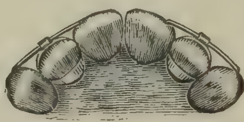


FIG. 292.

"Fig. 292 shows the teeth as retained by means of pieces of the anchor-wire (G, Set No. 1) passing through pipes attached to the labial surfaces of the bands, as described and shown in Fig. 288.

"The third method of moving a tooth from within outward is by lacing the teeth to the expansion arch, as in Fig. 293, force being derived from the spring of the arch and sustained by occasionally turning the nuts.

"The fourth method is by means of the wire ligature encircling the tooth and arch, force being exerted by occasionally twisting the wire as in A, A, Fig. 293.

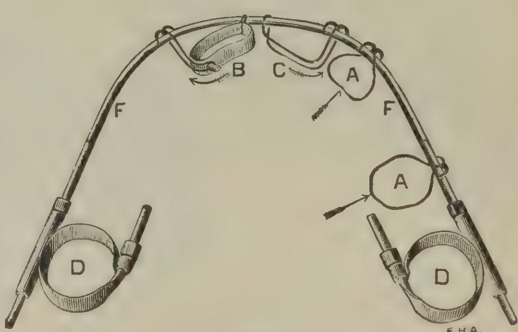


FIG. 293.

"A tooth may be moved inward by the small traction-screw B and C, Set No. 1, as shown in Fig. 294, in which a cuspid is being drawn into line, the bent end of the screw being hooked into the small tube C, Set No. 1, soldered to the band upon the anchor-tooth. The other end of the screw passes through a similar tube, against the end of which the nut works. To the tube is soldered a piece of the wire G, Set No. 1, bent at right angles and hooked into a pipe (R, Set No. 1), soldered to the lingual surface of the band on the cuspid. Force is exerted by turning the nut. The anchor-tooth was reinforced by a piece of the wire G, Set No. 1, resting in contact with the buccal surfaces of the adjoining teeth, and held in position by one of the small pipes R, Set No. 1. This anchor-wire was kept from turning by a very delicate pin passing through the pipe and one side of the wire, as in Fig. 288. Another way of securing this wire is by soldering it directly to the band.

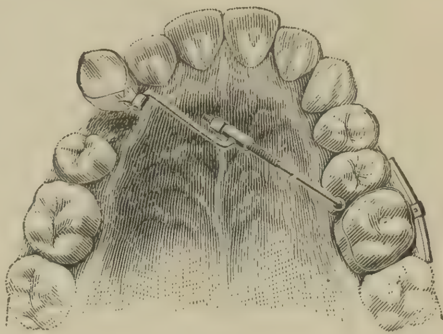


FIG. 294.

"Prominent teeth may also be forced into the line of the arch by means of the wire arch B, Set No. 2, or the expansion-arch E, Fig. 276, made to encircle the dental arch and bear against the prominent tooth, and the force may be intensified by an intervening wedge of rubber. The adjoining teeth are firmly laced to the arch by means of wire ligatures.

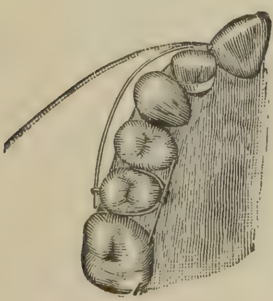


FIG. 295.—ROTATION.

"There are three principal modes of rotation by this system. First: By means of the lever, band, and tube, as shown in Fig. 295, which represents a lateral incisor in process of rotation. The incisor was cemented in position with an accurately-fitting band having soldered to it one of the small pipes R, Set No. 1, into which is inserted the end of one of the levers L, Set No. 1, the other end being sprung around and secured to a suitable anchor-tooth. This attachment of the end of the lever may be made in various ways,—either by being latched into a notch formed in the united ends of the band as shown in Fig. 295, or by a

wire ligature made to encircle the anchor-tooth and lever, or by a wire ligature encircling the button on the clamp-band (No. 3 or 4, Fig. 278), and attached to the end of the lever bent in the form of an eye, which is now my favorite method. The anchor-tooth may be reinforced by a piece of the wire G, Set No. 1, resting in contact with the lingual surface of the adjoining teeth, and held in position by one of the pipes R, Set No. 1, soldered to the anchor-band as shown. It will be seen that thus a constant, powerful, rotative force may be exerted upon the tooth.

"Care should be exercised that the lever be not allowed to pry against the intervening teeth, to force the tooth outward.

"It is often desirable to lace one or more of the intervening teeth to the lever by means of the wire ligature, to prevent overlapping of the teeth. The leverage may be increased by allowing the end to pass through the pipe, and to bear against the labial surface of the adjoining tooth. This may be intensified by an intervening wedge of rubber.

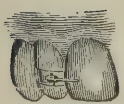


FIG. 296.—RETAINER.

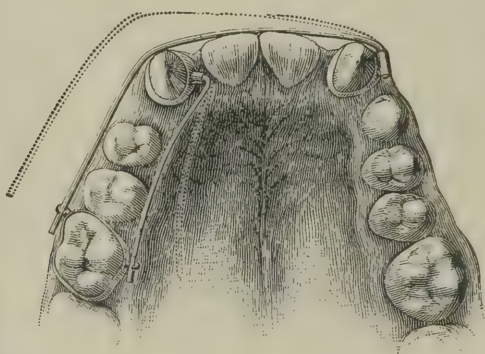


FIG. 297.


FIG. 298.

"Fig. 296 shows the rotated incisor retained by a short piece of the wire G, Set No. 1, slipped into the pipe from the opposite side and made to bear against the labial surface of the central incisor. There should also be soldered a spur to the disto-lingual angle of the band and made to bear against the cuspid.

"Fig. 297 shows two cuspids being rotated by this method. It will also be seen that the lever may be employed on the inside of the arch, and in this case there was the advantage of reciprocal anchorage resulting from the ends of the levers acting in opposite directions upon the anchor-tooth.

"In all similar cases where the lever is being employed on the outside of the arch it should be bent at the point nearest the labial surface of

the cuspid, so as to concentrate all the spring in the region of the moving tooth.

"Second: Rotation may also be performed, as shown in Fig. 298, by means of the jack-screw E and J, Set No. 1, secured by staple, clamp-band, and spur, and pushing against one side of the tooth to be moved, while the small traction-screw, attached by pipe R, Set No. 1, and piece of anchor-wire G, Set No. 1, soldered to the base of the sheath of the jack-screw, is made to pull upon the other side of the tooth. In this way perfect control of the tooth is gained, not only in rotation but also in pushing it outward or pulling it inward into the line of the arch, according as the nuts are adjusted. This method of rotation is principally limited to the superior central incisors or cuspids. It should be said that because of the powerful force they exert the nuts should be turned but slightly at each sitting. This is also another instance where use is made of reciprocal anchorage, which is to be taken advantage of whenever possible.

"Third: Rotation may be accomplished by exerting force on one side of a tooth by means of a wire ligature on the expansion-arch E, and a spur soldered to a band encircling the tooth to be moved, as at B, Fig. 293. This force may be intensified by a wedge of rubber stretched between the band and arch and acting upon the opposite side of the tooth. A modification of this plan of rotation is shown at C, Fig. 293, in which the band is dispensed with and the double or loop ligature is continued around the tooth, including the wire arch. This plan is less certain on account of the liability to slip: it is also less powerful, since the wedge of rubber cannot be used. It, however, will be found useful where teeth are to be but slightly rotated. At the same time a number of other teeth should be ligatured to the arch to secure greater firmness.

"When two teeth are to be rotated in opposite directions at the same time, as the central incisors shown in Fig. 299, double rotation may

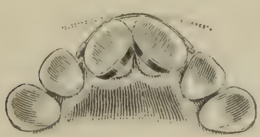


FIG. 299.

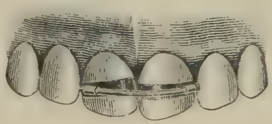


FIG. 300.—DOUBLE ROTATION.

be accomplished by a single lever. In this instance both the teeth are banded, and a tube soldered to each band. A straight lever is inserted in one tube, springing and sliding it into the other tube in the same manner in which a door-bolt is slid into position, as also shown in Fig. 300. It may be necessary to occasionally remove and straighten

the lever a little, in order to maintain the pressure. Should one tooth be rotated sufficiently before the other, further movement may be arrested by removing the band and soldering a lug on the lingual surface to rest against the lateral incisor. And should the teeth in rotation assume too much prominence, by reason of pressure from the adjoining teeth, it may be effectually corrected by requiring the patient to wear, for a few nights, the head-gear, traction-bar, and heavy elastic bands shown in Figs. 274 and 275, filing a deep notch in the end of the standard to engage the rotating lever.

"If the teeth show a tendency to separate as they rotate, they should be drawn tightly together by a ligature, made to encircle both tubes and held in position by the ends of the lever, slightly protruding through the tubes.

"When the teeth are in position they are retained by substituting a piece of the non-elastic wire G, Set No. 1, for the spring wire, or, better still, by uniting the bands with solder, and recementing them, as first suggested by Professor Guilford.

"Of the levers shown at L, Set No. 1, four different sizes are furnished. The smallest size is quite strong enough, in most instances, for double rotation, and is most commonly used by me, especially on the teeth of children.

"These levers are plated in such a manner as to nearly overcome the annoyance of oxidation and discoloration of the teeth in their use, thus obviating an objection to the employment of steel wire in the construction of regulating appliances.

"The reader should never confuse the wire G, Set No. 1, with these levers. Their uses are as different as the material of which they are composed. The levers are used only in rotation (occasionally in expansion), and are never united by solder in forming an attachment; while the wire G, Set No. 1, is extremely tough and malleable and has a very wide range of application, such as reinforcing anchorage, retention, making spurs, staples, etc.

"The elevation of a tooth in its socket may be accomplished as shown in Fig. 301, wherein a superior cuspid is being drawn out or erupted into line. The clamp-band No. 3, Fig. 278, was fixed on the lower second bicuspid. A very small hole was drilled into the cuspid, and a short pin was set with thin cement. A common pin answers the purpose very well, and the hole need not be deeper than the enamel if the pin is accurately fitted to it. A rubber ligature was given the patient with instructions to slip it over the pins, as shown in the engraving. The anchor-tooth in this case is directly opposed by the superior bicuspid. The anchorage is simple and efficient. The ligature may be worn at night only, so as to interfere as little as possible with speech

and mastication, although some patients wear it almost continuously. Too strong a ligature should not be worn, as it might endanger the life of the pulp, but gentle traction should be used, gradually directing the tooth into its proper position. The direction of force to be exerted upon the tooth to be moved will of course indicate which tooth in the inferior arch should be selected for anchorage. Should the anchorage fall upon a tooth with no antagonist, there would, of course, be danger of loosening it.

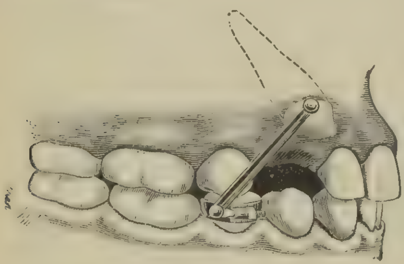


FIG. 301.

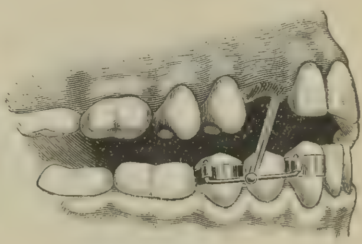


FIG. 302.

"Fig. 302 shows a case in which the anchorage was modified to suit the conditions. A deciduous cuspid had been retained too long, causing the permanent cuspid to remain in the alveolar process on the palatal side of the lateral incisor, necessitating a complex movement of the tooth backward, outward, and downward, requiring a very firm anchorage and a strong ligature. On the inferior cuspid and second bicuspid were fixed bands, having pipes R, Set No. 1, attached to their labial surfaces. A piece of the wire G of suitable length was bent at right angles and hooked into the pipes, as shown. The wire fits the bore of the pipe so accurately that in cutting off the ends which emerge through them, each end spreads sufficiently to prevent its coming out. A pin was soldered to the wire about midway between the pipes. The ligature was stretched from pin to pin, as seen in the engraving.

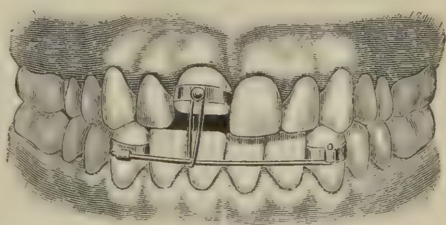


FIG. 303.

"Fig. 303 shows a modification of this method of anchorage. The anchor-wire was made detachable and the pin dispensed with, the patient slipping the wire through the ligature and into the pipes upon retiring, and removing it during the day. A delicate band (made of F, Set No. 1), to which was soldered the pin, was fixed on the moving tooth.

"Fig. 304 illustrates a case in which the appliances used were similar to those before described, but the wire anchorage was attached to teeth in the same arch in which was located the malposed tooth. The first bicuspid was banded and a pipe R, Set No. 1, soldered to the labial surface of the band, in which was hooked a piece of the wire G, Set No. 1, the other end of the wire being bent so as to rest on the cutting-edge of the lateral incisor. A pin was soldered to this wire, as in the case before described, and a rubber ligature stretched from pin to pin. In some cases where more force was necessary, I have used the combined anchorage described.

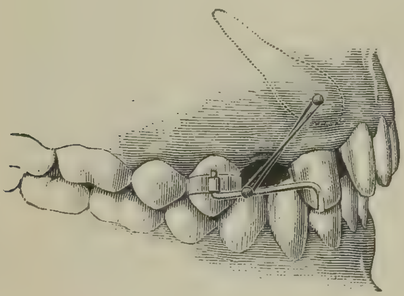


FIG. 304.

"A tooth may be elevated in its socket by employing either of the wire arches E or B as an anchorage; attaching the ligature to the tooth to be moved in any of the ways already described. Fig. 305 shows a case where all of the upper incisors are being elevated by this method. Considerable downward spring was given to the anterior part of the arch, by spurs attached to bands on the cuspids, which furnish a bearing or fulcrum for the wire arch. Force is exerted in this case by the downward spring of the wire arch after it has been attached to the moving teeth by wire ligatures or bands with spurs.

"There are several modes of expanding the arch by this system. First: By banding and tubing the first and last teeth of those to be moved on each side, and connecting them by means of wire (G) passing through the tubes. The jack-screw is then placed in position across the arch, from wire to wire. Collars R, Set No. 1, are soft-soldered to the wire at intervals to keep the screw in proper position. The jack-screw may be moved forward or backward,

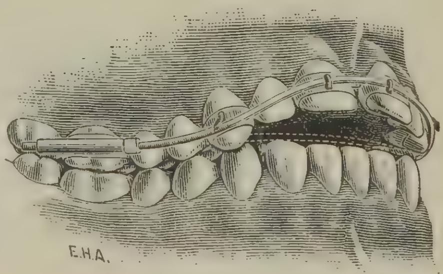


FIG. 305.

according to the varying requirements of the case. Before placing in position, the wires which pass along the sides of the arch should be bent to correspond to the shape of the sides of an ideal arch, or

exactly as we wish the teeth to be when finally arranged. The appliances in position are accurately shown in Fig. 306.

"Fig. 307 shows a modification of this method of expansion, the force being derived from one of the levers L, Set No. 1, bent in the form of the well-known Coffin spring, affording all the advantages of the Coffin method of expansion, without the disagreeable features of the rubber plate. Its chief advantage over the above method is that it may be also used in expanding the lower arch, without interfering with the movement of the tongue, as would jack-screws.

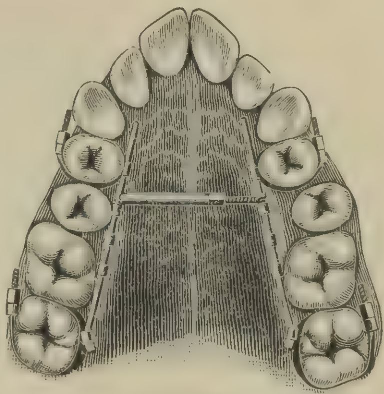


FIG. 306.

"The appliance for double rotation shown upon the central incisors has already been described, and is repeated only to illustrate how it may be used with advantage while the arch is being expanded laterally; the rubber ligature is used at the same time to retract the incisors.

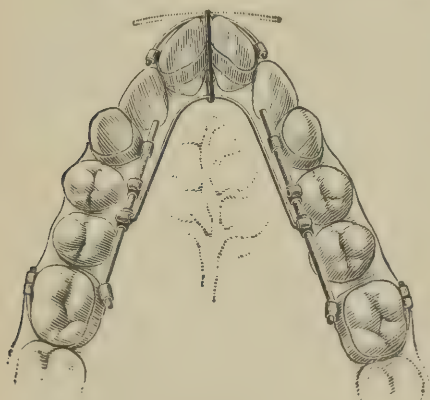


FIG. 307.

"The extra tubes, soldered at right angles to little collars slipped upon the bars on each side of the arch, are for engaging the expanding spring, should it be found necessary to transfer the pressure to that part of the arch. Should it be found necessary to move a tooth beyond this side bar, stretch a rubber wedge between the tooth and bar, as shown in Fig. 324. This simple method of moving a tooth beyond the limits of the appliance will be found valuable in connection with other parts of this system.

"Another method of expanding the arch laterally, as well as anteriorly, is by means of the appliances shown in Fig. 308, wherein the notched ends of the jack-screw engage a piece of one of the wire levers L, Set No. 1, held in position by notches formed in the united ends of the bands upon the lateral incisors. The sheaths of the screws

were held by solder to anchor clamp-bands on the first molars. The incisors were moved forward by turning the nuts upon the jack-screws, while the arch was being expanded laterally, by means of one of the spring levers L, Set No. 1, the ends of which had been bent sharply at right angles, and made to engage the delicate holes bored into the sides of the sheaths of the jack-screws, all as clearly shown in the engraving. A modification of this plan is to exert pressure laterally by means of a third jack-screw instead of the spring, this screw being notched at each end and made to rest in contact with the screws upon the sides of the arch, anterior to their nuts.

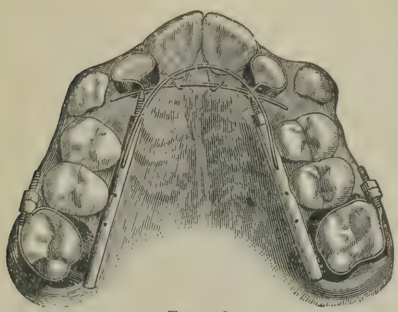


FIG. 308.

"Another excellent method of expanding the arch is by means of lacing the teeth to the expansion-arch E, shown in Figs. 274 and 276. The wire ligatures are occasionally tightened by twisting, until the teeth have been moved outward and made to conform to the shape of the wire arch. The increasing of the arch is provided for by adjusting the nuts in front of the tubes upon the anchor-bands. By this method, one or both of the lateral sides of the arch may be expanded, or the anterior part of the arch alone may be moved forward, in which case the teeth are laced to the arch and moved forward collectively by turning the nuts. (See Fig. 274.)

"In expanding the lateral halves of the arch by this method, the wire arch should be straightened sufficiently to give all possible spring, which in most instances exerts sufficient force. In cases where the teeth are extremely firm, the expansion-arch may be reinforced by the spring from one of the levers L, Set No. 1, bent to conform to the inside of the arch, and made to press upon the anchor-bands D. The ends of the wire are held in position by being bent at right angles, and slipped into pipes R, Set No. 1, which have been soldered at right angles to tubes, C, slipped

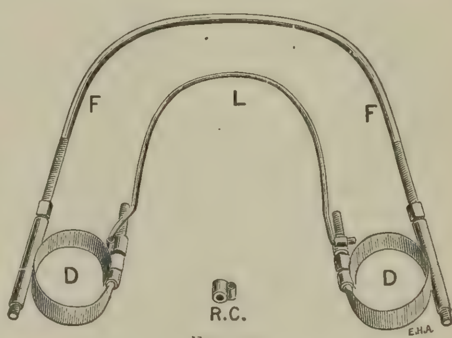


FIG. 309.

over the ends of the screw upon the clamp-bands D, all as shown in Fig. 309.

"If it is desirable to exert pressure only upon the bicuspids, the spring of L alone is sufficient, when held in proper position, by securing the ends in either of the following ways: By resting in one of the pipes R, Set No. 1, soldered to the clamp-band (the end of the pipe being closed as shown on the left of Fig. 310), the arch being bent so as to lie in contact with and also exert pressure upon the first bicuspid; or the end may be secured, as on the right of Fig. 310, by being bent to engage one of the pipes R, Set No. 1, soldered to the nut upon the clamp-band, the end of the band-screw resting against the first bicuspid. The nut must be removed from the screw while soldering, or pieces of the anchor-wire G may be soldered to the clamp-bands encircling the second bicuspids, the front ends in contact with the lingual surfaces of the first bicuspids. To these wires are soldered at right angles the

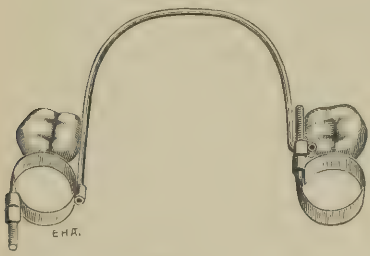


FIG. 310.

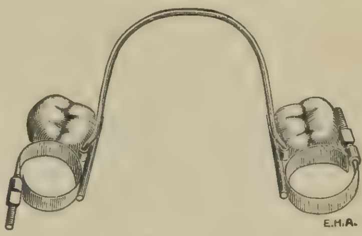


FIG. 311.

pipes R, which engage the ends of the spring, as in Fig. 311. Or the same attachment to the clamp-bands upon the bicuspids may be made as already described and shown in Fig. 309.

"If it is desirable to exert pressure upon one tooth only, a pipe should be soldered to the band over the tooth to be moved; in this pipe rests the end of the spring. Bend the spring so that all the force will be exerted upon the one tooth to be moved, while two or more teeth as anchorage on the opposite side of the arch antagonize this force. This latter plan will be found useful in moving outward or inward a single molar, which is sometimes desirable in order to establish perfect occlusion."

Dr. W. G. A. Bonwill in his description of his system of correctors for irregularities writes as follows:—

"1st. To commence as soon as possible after the seventh year, or as soon as there is evidence of decided irregularity.

"2d. To watch all children's teeth from the third year and determine, by an exploring needle every three months, the exact position

of the coming permanent teeth as soon as the first permanent molar has appeared.

"3d. To preserve, by early treatment, the first and second molars—temporary—even to the treatment of their pulps, if they were not brought in time to obviate it.

"4th. To be sure the first permanent molars are preserved without loss of pulp and allow nothing to interfere with their full and free development in the arches, as upon these teeth more than any others are due the irregularity, *by coming too far forward in the arch from decay of approximal surfaces of temporary molars, or from the tardy eruption of the permanent incisors.* The sixth-year molar drives the arch into smaller space when the incisors have appeared out of or inside the arch.

"If the arch is once interfered with the area is not so great, and consequently there will be a deeper underbite and the permanent molars will move forward and always keep them so, causing the permanent teeth which are yet undeveloped in the maxilla, and lying over each other and not in line, to roll over and shorten the whole maxilla in front of the permanent molar. *Therefore*, keep this tooth as far back toward the ramus as possible.

"5th. That all apparatus should be simple and, if possible, firmly fixed, that the patient can have no control over it, and then see the case every few days.

"6th. That constant and uninterrupted pressure is preferable. The antagonism of the opposite jaw will always be exerting a force to make them move back and forth in the sockets, which makes sufficient intermittent pressure.

"7th. That while one plan, without change somewhat to each case, will not do, yet the infinite number of such apparatus is a greater nuisance to patient and operator.

"8th. Take impressions of both jaws in plaster and a duplicate from the first; that the plaster teeth could be cut off and rearranged to see the effect, and these models placed in my anatomical articulator, where they could be studied in the lateral movements, so necessary. That this should be studied carefully; and, before action is taken, have the patient call and study the case in relation with the plaster model; and if doubt existed as to the extraction of a tooth or teeth, better postpone a few days and send for patient again rather than make so great a blunder.

"9th. That a tooth should be held as sacred as an eye; and, while extraction is sometimes demanded, when the greater good of the patient is at stake—when of weak constitution—yet do not too hastily resort to it.

"10th. That without the combined assistance of parent and child, better not commence.

"11th. That nothing should be withheld from the child or parent, but every detail, every risk, and the amount of patient endurance needed, the long time, and, when all is corrected, to allow of stay plates, that the work gained may be retained.

"12th. Not least of all the factors, I must mention (which I did not at first see) to place such valuation on the services as will insure your interest and will drive the parties concerned up to their duties.

"To these points I would now further insist on the great importance of utilizing as factors or fulcrums the temporary molars.

"1st. By shaping them with a disc on all their sides or surfaces, so that a gold clasp can be securely placed thereon. Figs. 322 and 333.

"2d. Where a ligature only is needed, to cut a groove with the disc on the buccal and palatal and lingual surfaces near the cervix, in which to place the silk ligature to keep it from working down under the gum. Fig. 332, C C.

"*These teeth will soon be lost, and no injury is done by shaping and grooving them.*

"3d. By the use of gutta-percha (Figs. 321 and 322), warmed and placed on the palatal or lingual side of the tooth, around which a ligature is to be placed and carried slightly up over the grinding surface to prevent the ligature from pressing down under the gum. This I use on permanent teeth.

"4th. Where the tooth cannot be cut or gutta-percha used, then gum sandarach varnish or a thin solution of oxyphosphate zinc placed on the tooth will prevent the ligature from slipping when the tooth is being rotated, or keep it from pressing up under the gum.

"The trouble has always been how to get hold of any of the temporary teeth as a fulcrum.

"It has been my practice for years to first make use of the silk ligature and rubber bands, without plates. To do so, how shall I prevent the ligature from slipping off the permanent tooth, and from slipping down over the temporary tooth used as the fulcrum?

"I argue that as the temporary cuspids and first molars will soon be lost after the permanent lateral incisors have come, and are high enough to get hold of, to cut a slot with a small hard-rubber disc on their buccal and palatal surfaces deep enough to hold the ligature which keeps it from ever passing down under the gum, Fig. 332. If I must make a plate of rubber or metal for the inside I use the same grooves to hold the plate in position.

"If I must have a clasp, which is now most frequently the case in the use of this new appliance, which I will presently show you, I cut the

first temporary molar on its mesial and distal surfaces a little under parallel, as at Fig. 333, and the strain is so slight it is not uplifted before the lateral incisor has been drawn into the circle. If there is any danger from the ligature wounding the gum, I place underneath gutta-percha. If I want to pass a ligature around a permanent tooth (Figs. 322 and 327), as a fulcrum, I simply warm a small piece of gutta-percha and press it on the palatal or lingual side of the tooth, letting it extend slightly down on the gum, and when cold and rigid cut two holes through it to let the ligature pass, and then between the teeth, and tied outside to the rubber band. This little adjunct cannot be overpraised, for it is so soon adjusted, is pleasant to the patient, and non-irritating to the tissues. I cannot tell you how much I love gutta-percha, and especially just here to save me so much plate work and irritation, and for keeping my children in good humor. If a metal wire or band is pressing into the gums, and a hook cannot be used on the grinding surface, the gutta-percha fills the need ; and it answers well as a fulcrum

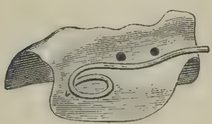


FIG. 312.

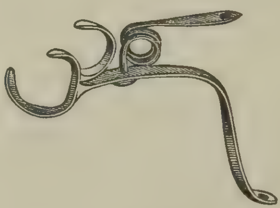


FIG. 313.

by letting the band directly into the gutta-percha or by attaching it to the wire or silk ligature that holds the former.

" The figures from 312 to 333 show all the appliances and their applications for irregularities. Fig. 312 to 317 show the spiral spring in various phases.

" Fig. 312 is a silver plate to fit the lower incisors tied on to a central to correct a superior central from the inclined projection on the right, and the end of spring acting on the right inferior central to throw it out of the arch.

" Figs. 313, 314, 315 are metal bands with clasps, with the spiral spring soft-soldered under a metal loop hard-soldered to the band. This retains the temper. These are used on many teeth in either jaw.

" Fig. 315 is a metal plate with half clasps fitted to the bicuspids to hold it in position. The spiral spring is soft-soldered to plate. This can be changed to various positions on plate, and is applicable to cases where it is difficult to place clasp entirely around a tooth.

"Fig. 316 was made for drawing backward the four incisors of inferior jaw with spiral springs, adjusted not to interfere with the tongue or superior teeth. The piece at A goes over the incisors and is held by ligatures tied to one or more of the teeth.

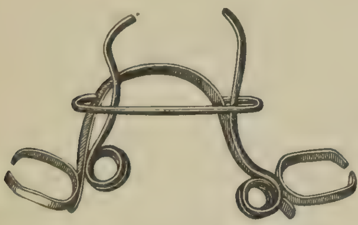


FIG. 314.

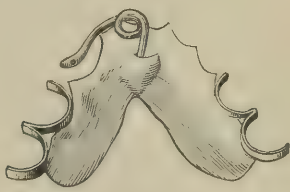


FIG. 315.

"Fig. 317 is a jack-spring for constant pressure. It may be made in a curve to conform to the hard palate. It is very powerful and effective and superior to a *jack-screw*.

"In all these spiral-spring appliances the spring is tied to the tooth to be acted upon to hold it from slipping; or, in some cases, a hole drilled into the tooth is better.

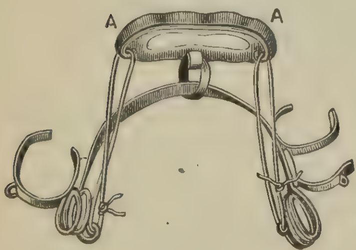


FIG. 316.

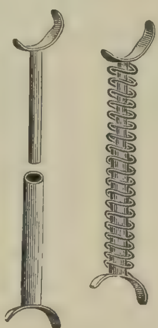


FIG. 317.

FIG. 318.—APPLIED IN FIG. 326.

FIG. 319.—APPLIED IN FIG. 330.

"The appliances that with me have superseded all others are seen in Figs. 318 to 333. Fig. 318 is a curved bar of platinized gold with four holes punched therein for the passage of silk ligatures. It is another way of applying Fig. 319 without band and used mostly for a single tooth in either jaw. The principle of action will be seen in Fig. 326, where two inferior lateral incisors are to be drawn from within out. To do so requires expansion of the jaws. This is effected by making the holes in the end of the plate over the center of each cuspid and by carrying the silk ligature from the mesial side of the laterals around back and up between the lateral and cuspid and through

the hole in plate at either end, and attached to a rubber band which is stretched between the holes. This pushes the cuspids backward or opens the arch, and the centrals move forward somewhat, and the laterals easily fill the breach. Once in position and they are retained without apparatus.

"If the holes through which the ligatures pass were made exactly opposite the laterals, no good would be effected, because the pressure would be as much down as out, and compressing the arch. But the ligatures applied as directed force the jaws apart, although the band is resting hard on the cuspids. The ligature is a loop or slip-knot, and must be applied so as to come out between the lateral and cuspid. Gum sandarach varnish will keep it from slipping around the tooth. The band, as heretofore applied, has not expanded the arches, because the holes were not in the right places—over the cuspids.

"Fig. 319 is this same bar with a clasp on one side of the arch. The bar is lengthened beyond the clasp to allow of the *rubber tubing tied at* B being attached far enough away from A for getting power.

"It is applied, Fig. 330, by clasping a first molar. The right central has to be twisted and the lateral also,

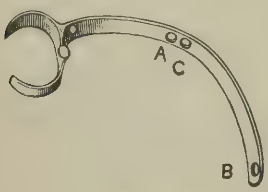


FIG. 320.—BAR SHOWN AS APPLIED, FIG. 322.

FIG. 321.—APPLIED IN FIGS. 322 AND 327.

but in the opposite direction. The bar rests upon the mesial buccal edge of the lateral while the silk ligature is carried *twice* around the central, bringing it up next the lateral and over it through the hole in the bar in the point where it rests on the lateral and is now drawn through the rubber band which has been tied opposite the molar. The rubber is stretched to the full length of the bar. The cuspid was also drawn outward on the same bar by boring a hole directly opposite, which can be made to twist the cuspid as well as to draw it outward.

"Fig. 320 is the same bar applied to Fig. 322 for drawing out both superior laterals and expanding the arch. The right cuspid is just emerging and the first bicuspid is clasped. The ligature with a slip-loop is carried over the right lateral, coming up from its distal side and through the hole in bar at A, and tied to the rubber band near the first bicuspid. The left lateral is ligated the same way, coming up through the hole at B, which is over the centre of cuspid. The ligature pressing the left cuspid backward is tied to the rubber band at C. Where the bar is too short to stretch the rubber band, it can be

lengthened on one side of the clasp or carried back to the right bicuspid.

"The lower jaw partially shows the application of the gutta-percha stay-plate (see Fig. 321) for keeping the ligature from off the gum at cervix, on the first molar. The lower jaw being too large an arch for the upper, I extracted the first right bicuspid, and as the right lateral inferior incisor was too far in the arch, and the right cuspid very far outside, I simply ligated the first inferior molar on the same side. A piece of pink base-plate gutta-percha was warmed and pressed up against the molar, letting it rest partially on the adjoining teeth (see Fig. 321); when cold, two holes were made in it for the passage of the ligature, which was tied on the buccal surface of the molar. A rubber band was tied to the inside before adjusting. A ligature is

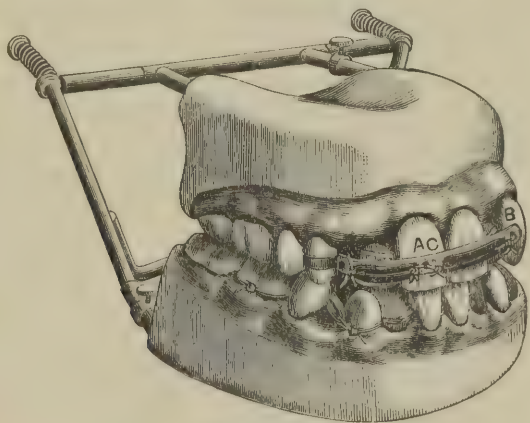


FIG. 322.

now cast around the right lateral, carried up between it and the cuspid, and over it through the space where first bicuspid was extracted, on the lingual side of the first bicuspid, and tied to the rubber band attached to the gutta-percha stay or helmet on the first molar, and stretched over the buccal surface of the cuspid. This drew the lateral out very forcibly. The ligature was lastly placed on the cuspid alone, and remained for six weeks without change.

"Fig. 321 is also applied in Fig. 327. This was a very contracted lower arch with a deep underbite. The arch was first expanded by the fixture shown in Fig. 323, made of piano wire, with half clasps of platinized gold at A A, made with small ears to rest on the grinding surfaces of the first bicuspids to prevent slipping down upon the gums. These clasps are soft-soldered to retain the full temper of the piano wire as a spring. It is a very cheap and easy way of making

such an apparatus and with a powerful spring, which such cases demand.

"In this case I could not afford to extract any teeth, because the incisors were already touching the gums on the palatal side of the superior centrals. In expanding the lower arch I obviated this deep over and underbite. The left lateral was very far inside the arch, and the cuspid so far as to nearly allow the bicuspid to touch the lateral. The silk ligature was now placed over the lateral and carried up next the cuspid. The first bicuspid was ligated with a stay-plate or helmet of gutta-percha on its lingual side, with the ligature running through both holes and carried around the first bicuspid and tied on buccal side. This prevented entirely the slipping of ligature upon the cervix. A rubber band was now stretched between the lateral

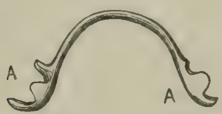


FIG. 323.—APPLIED TO FIG. 327.—EXPANDER OF BICUSPIDS, LOWER.

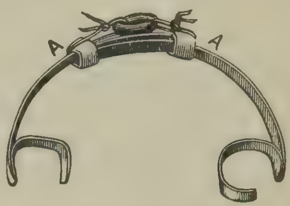


FIG. 324.—SHOWN AS APPLIED, FIG. 325.

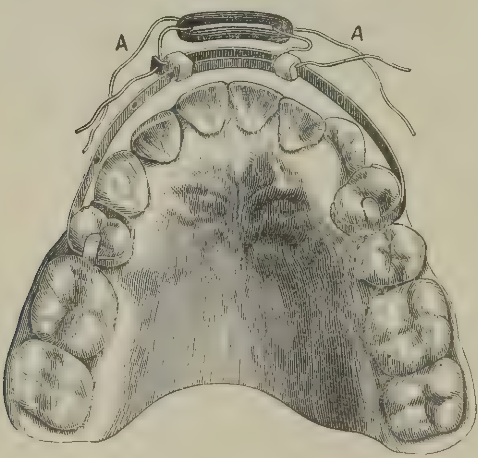


FIG. 325.

and bicuspid and secured. This expanded the arch in front and drew out the lateral in a very short time. Had to change once for a broken or slipping ligature. These little gutta-percha caps or helmets work admirably and are not worn or displaced in mastication.

"Fig. 324 is another modification of Fig. 320, or single bar, and is

applied in Fig. 325, where the four superior incisors are to be moved forward from one-fourth to three-eighths of an inch and the whole arch expanded to meet the more perfect and larger arch in the lower. It is made of two flat bars of platinized gold sliding over each other for at least two (2) inches. A loop is soldered to the end of each flat bar as guides to hold them in place while sliding through. A rubber band is shown attached to the end of each bar at A A, which, in contracting, enlarges the circle and consequently not only throws out the incisors, but the bicuspids and cuspids as well.

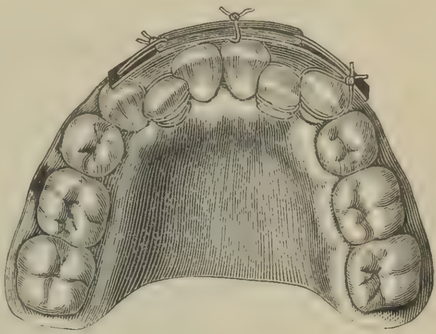


FIG. 326.

"The attachments are made on either side to a molar or bicuspid, owing to the ease of clasping. I have utilized the decay on anterior surface of a molar by filling with amalgam and cutting a hole into it for one end of the bar to rest, instead of a clasp.

"The apparatus is shown applied in Fig. 325, with the bars some distance away from the incisors to be attacked.

"Before the apparatus is placed permanently in position the four incisors are ligated with a loop, as shown in Fig. 332, using gum sandarach varnish to prevent slipping or turning on the tooth. The ligature should be so adjusted as to twist the tooth if needed while drawing it forward. These are now tied to the sliding bars, bringing them closely in contact with all the teeth in the arch. The rubber band is now tied between the two points A A, and the application is complete. It is easy to see not only its simplicity but its great effectiveness. It can be used equally well for contracting an arch.

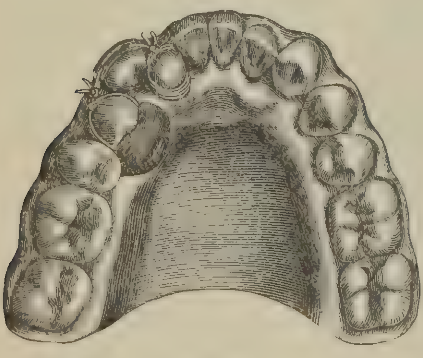


FIG. 327.

"Fig. 328 shows the worst case of protrusion of the upper jaw I ever saw. It was not done by an acquired habit, nor did it have any precedence in

heredity. The temporary teeth had proper arches. No cause could be assigned. They came as you see in Fig. 328. The lower incisors, when I first saw the case, were three-eighths of an inch from the superior incisors on their palatal surface, and were imbedded into the gums on the hard palate.

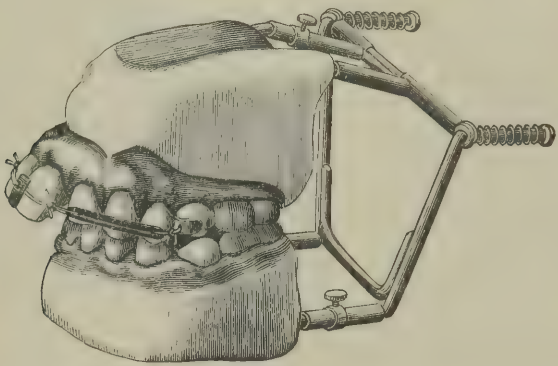


FIG. 328.

"Before attempting to draw in the incisors I made a rubber plate (Fig. 329) to cover the hard palate, thickened where the lower teeth would touch, and opened the jaws at the bicuspids at least one eighth of an inch. This was not only to drive the inferior incisors up further into their sockets, but to allow the bicuspids and molars to come down and antagonize before the plate was removed.

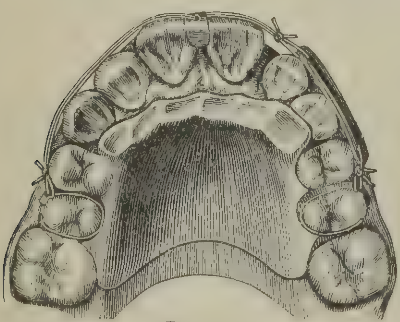


FIG. 329.

"Two years were consumed in this. To this plate I now attached a rubber band carried entirely around the arch, with a silk ligature, and at the central incisors I made a metal hook, carried over their cutting edge, with two holes through which the ligature passed. This kept the ligature down on the incisors near the cutting edges, and while it was aiding in drawing in the arch it did another important thing: forced the centrals up into the alveolus. This was done by the tendency of the rubber band to work up toward the gums, and at the same time it pressed them up and made them shorter without grinding. This was a parallel case with the one delineated by Dr. Kingsley in "Oral Deformities," but without any of the treatment given there. The

sliding band in Fig. 324 would have done well here, but I adopted the simpler one of ligature and rubber. To secure it a gold band running over the arch from the second bicuspids, which was soldered to clasps around the latter, which could be adjusted or removed by patient.

"The rubber plate was removed as soon as I commenced to draw

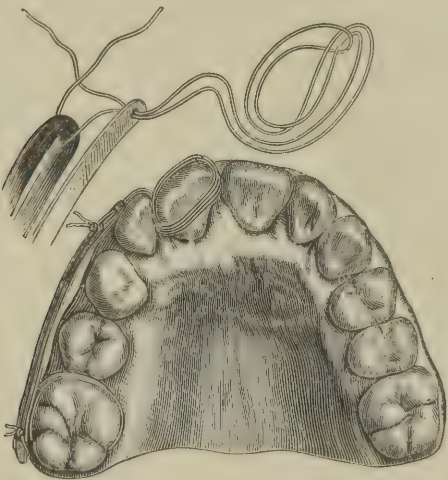


FIG. 330.

the incisor into the arch, to give room for them to fill a smaller arch. Fig. 331 shows the application of the band in the lower jaw, where the temporary molars are still in place. The permanent laterals are far inside the arch. The temporary cuspids also remained. The first molar has had all its sides squared to retain a clasp. A platinized gold bar, similar to Fig. 320, with clasps, is used, with a hole at the end of bar C; and then opposite the right central incisor, with another over the centre of the right temporary cuspid at G, and the fourth hole at the end of bar near the first molar at B.

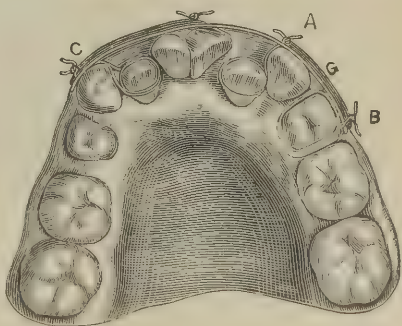


FIG. 331.

"The principal feature about this is, aside from the bar, the cutting so heroically the temporary molars for retaining the plate. This does no injury, and if it was likely to, they would soon have to be extracted for the bicuspids.

"The ligatures are applied as in all former cases of this bar, so as to press backward as well as drawing outward. In this case two separate pieces of rubber band are used.

"Fig. 332. The feature about this case which makes it novel and unique is the utilization of the superior temporary cuspids for holding the ligature. To place a ligature on the temporary teeth insures their removal or extraction without this plan. To keep the ligature on the body of the tooth I take a small hard-rubber corundum disc and

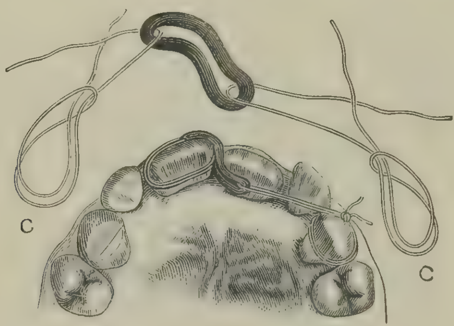


FIG. 332.

make a groove on both the labial and palatal sides of the cuspid, deep enough for the ligature to rest securely. If necessary, I should do it to the first or second temporary molars, if a ligature could be gotten around the incisor to be turned into place.

"The rubber band is drawn through and between the centrals, which gives it more power over the incisors. The left superior lateral was soon placed in the arch.

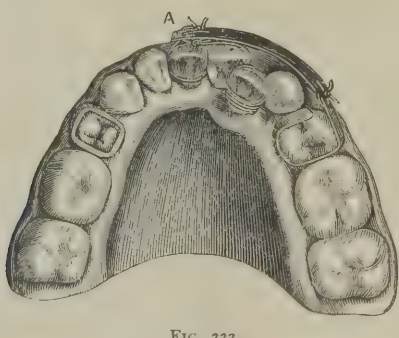


FIG. 333.

"Fig. 333 shows the cut surface in first temporary molar on the left and as applied on the right with the clasp around it attached to the bar. The ligature passes between lateral, over central, and through hole in the bar at A, pressing central to the left and molar to right."

CHAPTER II.

TREATMENT OF DENTAL CARIES.

The treatment of dental caries is one of the most important operations in dental surgery, because of the usefulness of the organs to be saved, the universality of the disease, also the complex and difficult nature of the treatment required. The caries may be slight and superficial, or it may be more or less deep-seated; lastly, it may penetrate even to the pulp-cavity. The difficulties of treatment increase in the same order, and in this order they will be taken up. Caries, when superficial, may be arrested by the same means used for deeper caries; but in a large number of cases it will require for its removal only the use of files, enamel chisels, or discs. These instruments are also often used preparatory to the operations necessary for the arrest of deep-seated caries; hence their use demands our first consideration.

Such instruments as enamel chisels, discs, etc., have, in a great measure, however, superseded the file for the permanent separation of teeth and the removal of superficial caries.

Treatment of Superficial Caries.—There is no operation in dental surgery against which a stronger or more universal prejudice prevails than that of filing the teeth, yet, when judiciously and skillfully performed, it often proves beneficial in arresting the progress of caries. Although productive of much good, it is, in the hands of unskillful operators, a source of incalculable injury.

In filing the front teeth and those on the right side of the mouth, the operator should stand to the right and a little behind the patient, in order to steady the head, as it rests against the back of the operating chair, with his left arm, while with the fingers of the left hand the lips are raised and the teeth properly exposed for the operation. In filing the teeth on the left side of the mouth it may be necessary for the operator to stand upon the left side of his patient. The file, firmly grasped between the thumb and middle finger of the right hand, with the end of the forefinger resting upon its outer end, should be moved backward and forward in a direct line, as any deviation from this would immediately snap the instrument. The first opening between the teeth, when the approximal edges of the two are carious, should be made with a flat file about one-fourth of a line in thickness, cut on both sides and both edges; this done, a file cut on one side and both edges should be employed for the completion of the operation. If only one tooth is decayed the operation may be commenced and completed with a safe-sided file. The file, during the operation,

should be frequently dipped in tepid water to prevent it becoming heated or clogged while in use; especially should the water be warm or tepid where the teeth are sensitive. When the files become so much clogged that the water or a brush will not cleanse them, a brass or steel scratch-brush may be used, or they may be dipped in sulphuric or chlorhydric acid, and then washed with the greatest care, to remove every trace of acid.

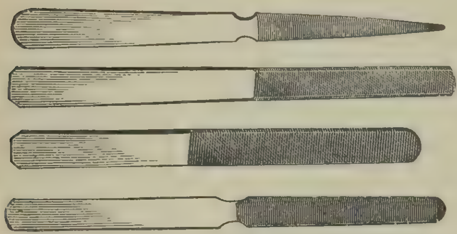


FIG. 334.

Fig. 334 represents various forms of thin separating files.

Fig. 335 represents forms of flexible separating files.

To secure the success of the operation it is sometimes necessary to cut away a considerable portion of the tooth; but in doing this the operator should be careful not to destroy the symmetry of the labial

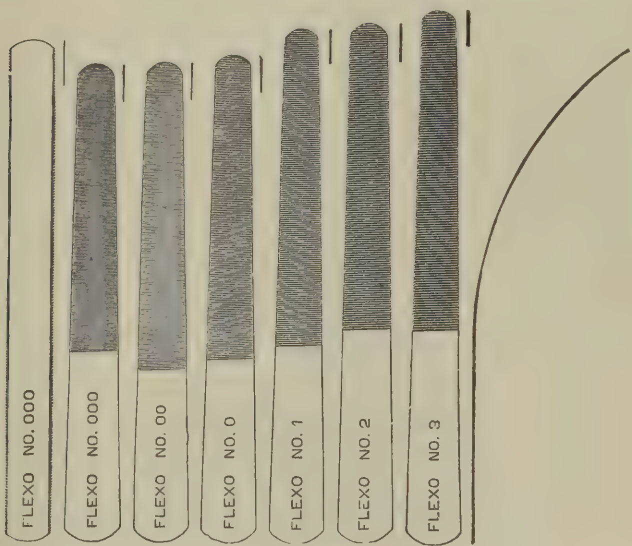


FIG. 335.

surface. The aperture anteriorly should only be wide enough to admit of a free oblique or diagonal motion of a safe-sided file of about one-fourth of a line in thickness, or a correspondingly thin corundum disc. In this way one-fourth or more of a tooth may be removed without materially altering its external appearance. But a tooth should

not be filed entirely to the gum ; a shoulder should be left, to prevent its approximation to the adjoining tooth. Sometimes the decay is of such size and so situated that it may be removed by means of enamel chisels with less alteration in the external or labial surface of the tooth. These very valuable instruments will also be found useful for rapid cutting preparatory to the slower action of the file. A rounded form

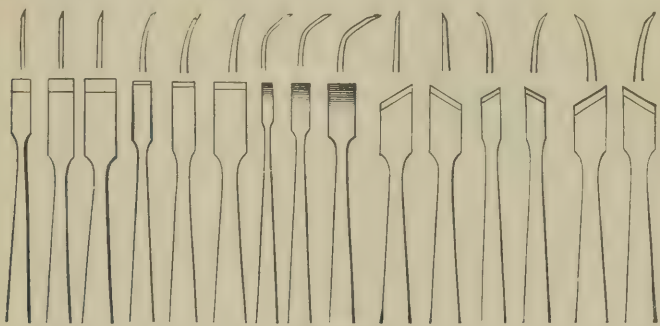


FIG. 336.

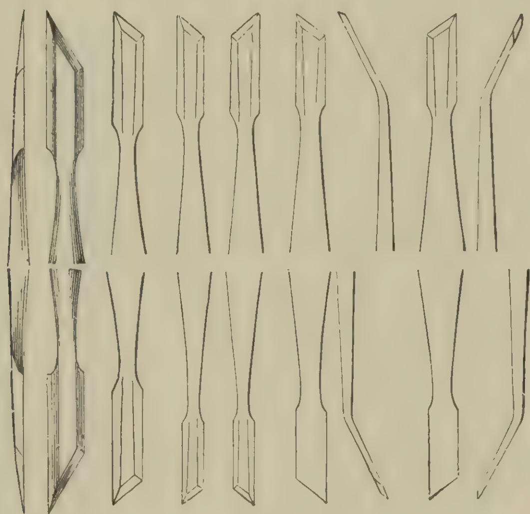


FIG. 337.

can be given by them to the inner angles of the teeth, for which purpose they may either follow or take the place of the file.

Fig. 336 represents a set of enamel chisels, straight and curved, by which the operation of removing a portion of the crown of a tooth can be performed much more rapidly than by the file, and also with more comfort to the patient.

Fig. 337 represents a set of Dr. Louis Jack's Double-end Enamel Chisels.

Fig. 339 represents Dr. W. W. Evans's set of Enamel Chisels.

When operating upon the front teeth with the enamel chisel, the instrument should be firmly grasped in the hand, near to its cutting edge, and the edge applied to the surface of the portion to be removed, while at the same time the point of the thumb uses as a fulcrum the cutting edge of the tooth or the one adjoining.

For operating upon the bicuspid and molar teeth, heavier enamel chisels are required than in the case of the front teeth, and with either straight or oblique cutting edges. The curved form of chisel is useful when the mouth is small and it is difficult to reach the point desired with the straight form.

Fig. 338 represents Dr. Gordon White's fixed blade separator for immediately separating teeth without loss of substance. It is manipulated by forcing the thin portion of the blade between the teeth to be separated, then pulling outward slowly and firmly, with a little swaying motion, until the proper space is obtained. The force so applied tends to spread the teeth outwardly, the reverse of the keystone action of the ordinary wedge, and thus a wider space is very easily obtained.

When the decay occupies a large portion of the approximal surface and has penetrated into the tooth to a considerable depth, destroying the enamel anteriorly and causing it to present a ragged and uneven edge, it will be necessary to form

FIG. 338.

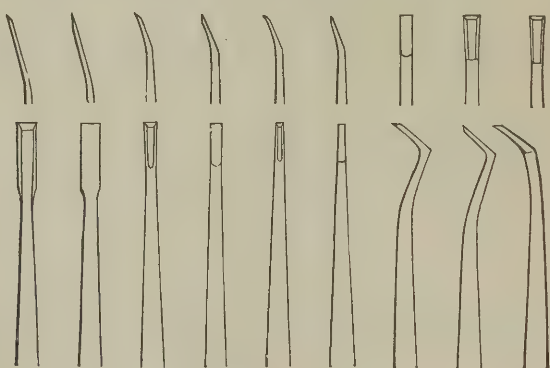
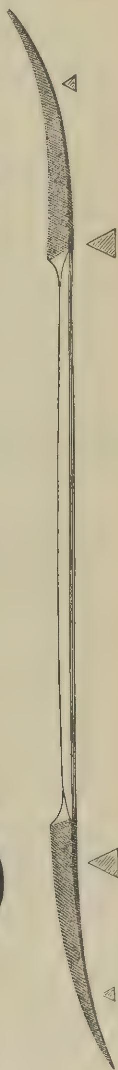


FIG. 339.

a wider exterior aperture than mere regard for appearance would dictate. When the approximal surfaces of the two front teeth are affected

with caries, about an equal portion should, if circumstances permit and it is necessary to cut away tooth substance, be filed or cut from each tooth. In the case of delicate front teeth, or teeth slightly loose in

FIG. 341.



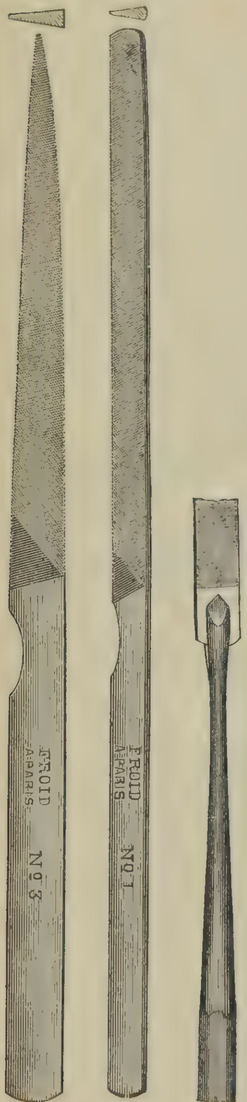


FIG. 340.

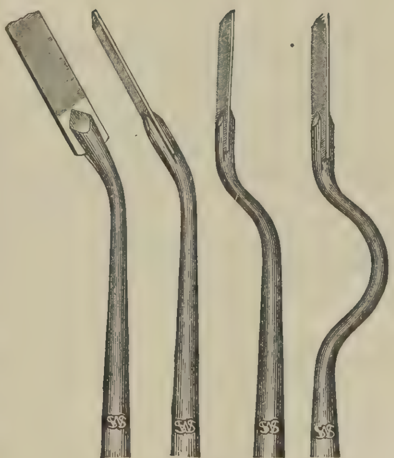


FIG. 342.

their cavities, it will be well before filing to mold a small piece of gutta-percha or modeling composition around or against the inner

surfaces of the tooth to be filed and several adjoining ones. It gives support to frail teeth, and greatly lessens the danger of irritation from the motion imparted by the file to the teeth which are not firmly set in their sockets. Some use for this purpose plaster; but we think the gutta-percha or modeling composition, as suggested by Prof. Gorgas, will be found altogether more conveniently applied and more agreeable to the patient.

When the file is employed for separating the superior incisors and cuspids, the operation may be completed with a bevel-edged file, as no sharp angle should be left near the gum.

In separating the bicuspids by filing, a space should be made somewhat in the form of the letter V; it should not, however, form an acute angle at the gum. This space should also be slightly wider toward the palatal and lingual surfaces. For its formation a V-shaped file, which is one beveled on both sides, will be found most suitable. A space shaped in this manner will prevent the approximation of the

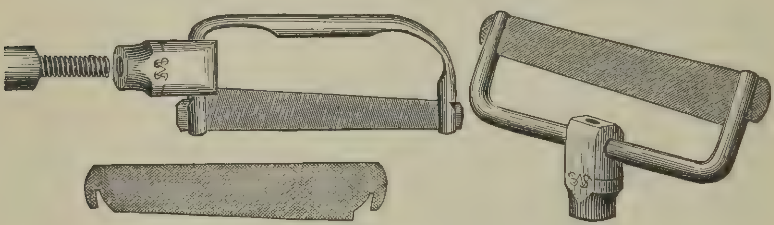


FIG. 343.

sides of the teeth, and if filling be necessary, it will enable the operator to do it in the most perfect manner.

Fig. 340 represents knife-edge or bicuspid-pointed and blunt files.

Fig. 341 represents a file designed by Dr. E. Parmly Brown for contouring the approximal surfaces of molars and bicuspids. It is three-sided and cut on all sides.

When the separation of the molar teeth in this manner becomes necessary the same shaped space should be formed. But as these teeth are situated far back in the mouth, it cannot often be done with a straight file; to obviate this difficulty, an instrument with which every dentist is acquainted, denominated a file-carrier, is usually employed.

Fig. 342 represents Dr. J. E. Line's file-carrier, which is simple in its construction as well as very serviceable.

Fig. 343 represents Dr. W. B. Miller's file-carrier, which admits of changing direction and slant very quickly.

Fig. 344 represents a cheap and simple file-carrier, the device of

Dr. D. M. Clapp, either straight or curved, which will carry a thin separating file, and also finer ones for cutting metal.

A file-carrier attachment for use with the dental engine has also been devised, but it is not so readily controlled as the hand instrument.

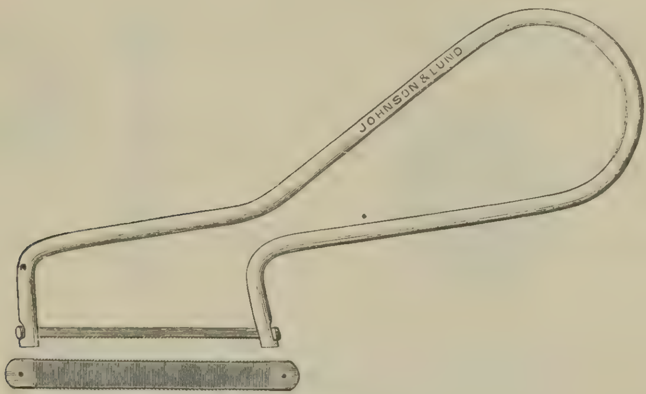


FIG. 344.

A great variety of **V**-shaped separating files are now to be found in the dental depots, from English, French, and American manufacturers. Fig. 345 will give a correct idea of some of these shapes.

Discs composed of different substances, and attached to mandrels, for use with the dental engine, are employed for separating teeth that

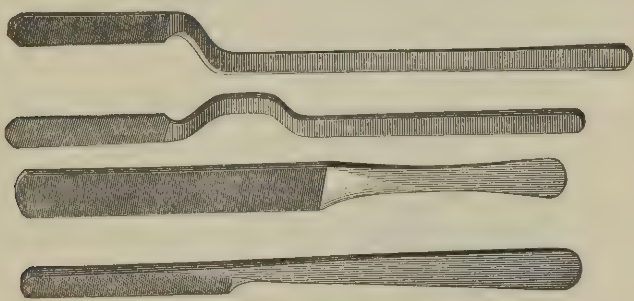


FIG. 345.

are affected with superficial caries on their proximate surfaces, and also for removing superficial caries from such surfaces. Figs. 346 and 347 represent the diamond disc, composed of a thin plate of metal, such as nickel, in which diamond powder is thoroughly incorporated. The corundum discs, Fig. 348, introduced by the late Dr. Robert Arthur, of Baltimore, are now used, to the almost entire exclusion of files, in separating teeth, especially *molars and bicuspids*. Although often

28

employed for separating the incisor teeth, they require careful manipulation for such delicate operations, on account of being less readily controlled than the chisel or file. The incisor teeth, being much smaller than the posterior teeth, should never be cut in the same proportion. When the disc is used for separating the anterior teeth the greatest care should be exercised to avoid too much cutting, especially of the labial angles.

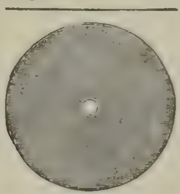


FIG. 346.

FIG. 347.

These discs are similar in composition to the ordinary corundum wheels used for grinding porcelain teeth, being composed of emery powder and gum shellac, which, being softened by heat, is rolled into

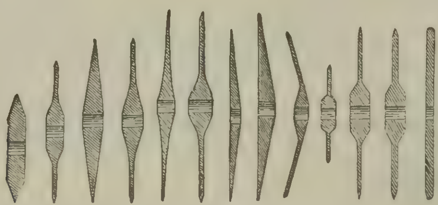


FIG. 348.

a great variety of shapes to suit the different operations to be performed by them. The discs thus formed are mounted on mandrels

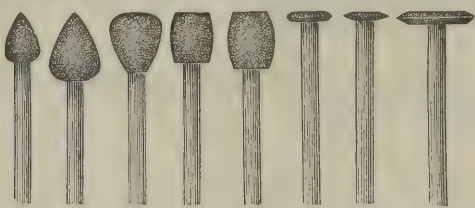


FIG. 349.

(Fig. 350) for use with the dental engine, an instrument which will hereafter be described.

Fig. 349 represents a few forms of Dr. A. L. Northrop's corundum points for cutting and polishing.

Fig. 350 represents different forms of mandrels, with and without shoulders, for mounting corundum, diamond, rubber, celluloid, boxwood, emery-paper, sand-paper, and cuttle-fish paper discs and points.

After a sufficient portion of the tooth has been cut away the surface

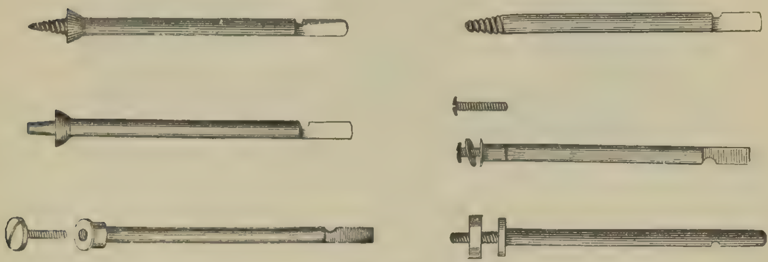


FIG. 350.

should be made as smooth as possible, with a very fine or half-worn file, or with Arkansas, Hindostan, or Scotch stones, wood polishing points, discs of soft or hard rubber, boxwood, felt, emery, sand or cuttle-fish paper, carrying powders such as pumice, silex, emery, buck-

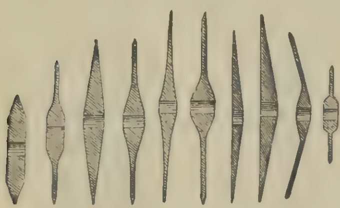


FIG. 351.

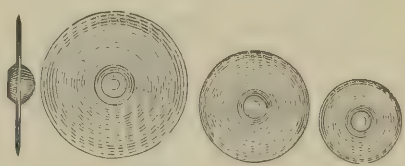


FIG. 352.

horn, corundum flour, Hindostan, Arkansas, etc., etc., or with tape charged with such powders.

Fig. 351 represents hard rubber discs for carrying powders for polishing the natural teeth and finishing fillings.

FIG. 353.

Fig. 352 represents boxwood discs.

Fig. 353 represents corrugated soft rubber discs and points for carrying powders for polishing.

Fig. 354 represents emery, sand, and cuttle-fish paper discs.

Fig. 355 represents points of Arkansas, Hindostan, and Scotch

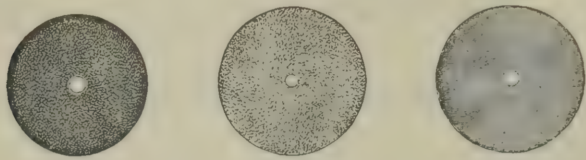


FIG. 354.

stones, mounted on mandrels, for polishing the natural teeth and fillings.

Fig. 356 represents wood polishing points, which are screwed into a mandrel for use with the dental engine. These points are also service-

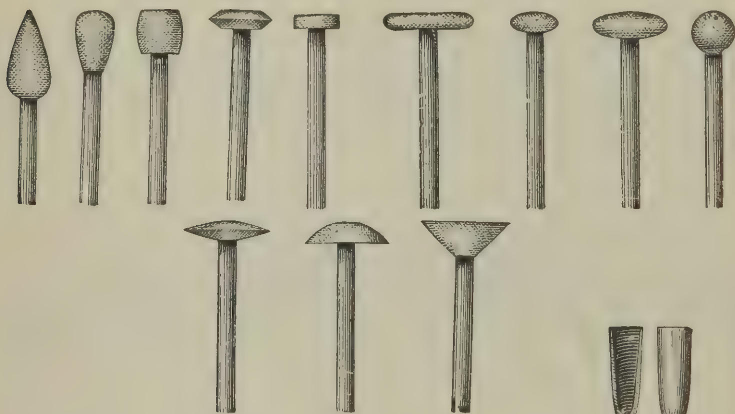


FIG. 355

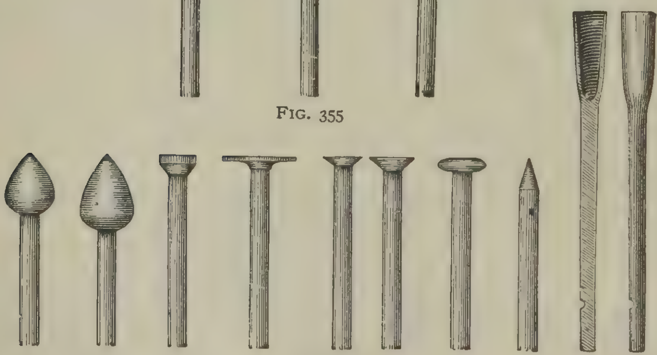


FIG. 356.

able for removing discoloration from the teeth, such as results from depositions of calculus.

Dr. George H. Cushing's Changeable Angle Disc Carrier, Fig. 357, is easily attached and removed from the dental engine hand-piece, its angular range being indicated by the dotted lines.

A fountain mouth protector (Fig. 358), while protecting the tongue and cheek from injury, serves also to keep the disc wet. A supply of water is stored in the rubber bulb of reservoir B, by compressing and immersing it in water, and is fed as required through the small aperture seen in the cuts by a touch of the finger on the bulb. The tube

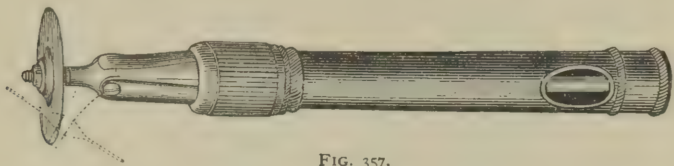


FIG. 357.

A is sprung over the hand-piece, and may be turned for use in any part of the mouth.

Fig. 359 represents Dr. F. Herrick's fountain drip-point, intended for keeping up a continuous dripping of water upon corundum points, engine burrs, and other rapidly revolving instruments.

When removing superficial caries all edges and sharp corners should be rounded and made smooth, and when the operation is completed the patient should be directed to keep the excised surfaces of tooth-structure perfectly clean, for if the secretions of the mouth or extraneous matter be permitted to adhere to such surfaces a recurrence of the disease will take place. Prior to removing superficial caries from the approximal surfaces, and especially of the front teeth, such teeth may be separated by pressure made with wood, cotton, tape, or rubber,

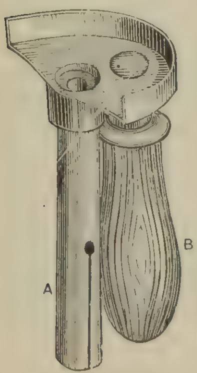


FIG. 358.

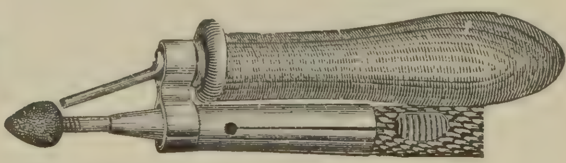


FIG. 359.

so that unnecessary cutting of enamel may be avoided, and but little more of the tooth-structure be removed than the decalcified part. When a portion of the approximal surface of a tooth is cut away, the excised surface should be left free and exposed to the friction of the tongue and lips, which will prevent food and other extraneous matters, as well as the secretions of the mouth, from lodging and remaining in contact with it. The portion cut away should be as much as is possible from the posterior part of the approximal surface, especially in

the case of the front teeth, so as to prevent any noticeable disfigurement. When superficial caries is located on the approximal surfaces of the bicuspids and molars, and near to the grinding surfaces, it may be removed by cutting out a V-shaped space between such teeth. When enamel chisels are employed for removing superficial caries, the instrument should be grasped near its cutting edge, which should be applied in the line of the enamel fibres, using the adjoining tooth as a fulcrum for the thumb, in order to prevent the instrument from slipping and wounding the soft part adjacent. Having in such a manner removed the overhanging enamel, the softened or decalcified dentine should be cut away with a scoop-shaped excavator, the use of which will also determine the depth to which the caries has penetrated, and if not too extensive, the enamel chisel can again be employed until the surface is made level or uniform. All edges and sharp corners should be rounded and made smooth, and it may be necessary, in order to complete the cutting process, to use a curved fine-cut file. Corundum discs operated with the dental engine may be found more convenient for the removal of superficial caries, and especially in the case of the bicuspids and molars, to be followed by strips of emery cloth or paper of the fine grades; also discs of fine sand-paper. When a perfectly smooth and normal surface is obtained, it should be highly polished with pulverized pumice or silex applied on linen tape, or on discs of flexible rubber, boxwood, or celluloid, completing the operation with polishing putty (peroxid of tin). The corundum and Arkansas or Hindostan stone points, followed by the use of wood points for the application of the polishing putty, will be found useful for removing superficial caries from exposed surfaces. When the operation of removing superficial caries is completed, the patient should be directed to keep the excised surface of tooth-structure perfectly clean. Caries upon the approximal surfaces of the teeth may be prevented by occasionally polishing such surfaces and passing floss silk between the teeth in connection with the use of the tooth-brush.

Since the introduction of the dental engine the removal of superficial caries and the preparation of the excised surface can be very effectively performed; and it should be remembered that such a surface should be left self-cleansing, so that deleterious substances may not lodge and remain in contact with it.

For separating the teeth to obtain space for the free use of the instruments employed in preparing and filling cavities on the approximal surfaces, the reader is referred to the "Treatment of Deep-seated Caries."

Separation of the Teeth.—Before a cavity can be prepared in the

approximal surface of a tooth, it is usually necessary to separate it from the adjoining one. This may be done either with a file, enamel chisel, corundum disc, or by the pressure of some interposed elastic substance, or by wedges of wood driven between the teeth, or by metallic wedges or separators. Each of these methods has its advantages. When caries has extended over nearly the whole approximal surface, so that after the removal of the diseased part the orifice of the cavity will be surrounded by a thin, brittle, and irregular wall, the former is the preferable method, especially in individuals having a decided scorbutic tendency, or who have suffered from the use of mercurial medicines or syphilitic disease, and in aged persons. But when the caries has spread over only a small portion of the surface of the tooth, and is surrounded by sound, healthy enamel, the latter method should be adopted, especially in individuals in whom there is no manifest tendency to inflammation or sponginess of the gums and in young subjects. The manner of separating teeth with cutting instruments has been already described; it will only be necessary, therefore, in this place, to offer a few remarks on separating by pressure, which was first adopted by Dr. Eleazer Parmly.

The following are its advantages, where it can be resorted to with safety: after the removal of the pressure the teeth almost immediately come together, leaving no space to injure their beauty; what is of still greater importance, the dentine around the external surface of the filling is not exposed to the action of the secretions of the mouth, or other agents capable of exerting upon it a deleterious action. On the other hand, some are of opinion that when the teeth come together again a lodgment is afforded to corrosive agents, upon the presence of which the disease was, in the first instance, produced, and which would soon cause a recurrence of it. In replying to this objection it is only necessary to observe that the parts of teeth first attacked by caries were the points in contact with each other, where the enamel may be supposed to have sustained some injury by pressure, thus rendering them more vulnerable at these points to the action of the causes that produced the disease. By properly replacing the diseased parts with gold, the external surfaces of the fillings will be the only parts that come in contact with each other, and if of gold will not be liable to injury from the above-mentioned mechanical causes. The enamel around the fillings, if proper attention to cleanliness be observed, is not so liable to be acted on by chemical agents as the dentine which the cutting instrument would expose.

But teeth cannot always with impunity be separated by pressure; it can only be done with safety in certain cases. As a general rule, the writer is of the opinion that it ought not to be attempted after the

thirtieth or fortieth year of age, though it may sometimes be done with safety at even a later period. The diseased action excited for the time in the sockets of the teeth does not so readily subside at a later age; and it has in some instances been known to result in the loosening and ultimate loss of the organs. In one case which came under the observation of the author the inflammation extended to the pulp, causing its disorganization and the consequent death of the tooth.

The pressure ought never to be too actively exerted; it should be gradual and constant. From three to five days are usually required for the separation of two teeth sufficiently for the removal of the decayed part and the introduction of a filling. After they have been separated in this way, they should be kept apart, without any increase of pressure, until the soreness in the cavities shall have subsided, before any further steps are taken in the operation. Cotton saturated with sandarach varnish, or white gutta-percha, or zinc filling materials, may be used to retain teeth after being separated with other substances, or by the rapid method. Only two teeth should be separated in the front part of the mouth in the same jaw at the same time. As soon as the cotton or tape, or other substance used to separate teeth, has afforded the desired space it should be removed, and the space retained for one or two days by cotton saturated with sandarach varnish, or white gutta-percha, or one of the zinc filling materials pressed between them, when the teeth may be well enough to permit of being operated on.

The pressure is usually made by introducing between the crowns of two teeth a thin wedge of soft wood, a piece of India-rubber, tape, a little raw cotton or ligatures, replacing the first-named substances every day or two with thicker pieces. While some prefer India-rubber to any other substance employed for the purpose, the object may be readily attained with other substances. Cotton or tape pressed firmly between the teeth and renewed daily, also gutta-percha, will in the course of a few days separate teeth, and with less soreness than India-rubber, to the use of which many object on account of the irritation it causes. Many operators prefer gradual pressure in separating teeth, but others, on account of economy of time, consider it better for the separation to be made at once, and not prolonged through several days. It is also urged that the patient suffers less and that there is also less danger to the teeth, in rapid separation than where this process is gradual. The degree of pressure and the method by which the separation is to be accomplished should, however, be determined by the susceptibility of the parts to inflammation. The operation of rapidly separating the teeth consists in the use of two wedges of fine-grained wood, either orange or boxwood. The first wedge is forced between the necks of the teeth, care being taken not to lacerate the gum, while

the second wedge, which tapers more than the first, is inserted between the points of the teeth, the wedges being driven alternately by mallet force, until sufficient space is obtained, when the second wedge is removed. Very great care should be exercised in driving the second wedge between the points of the teeth, on account of the force exerted

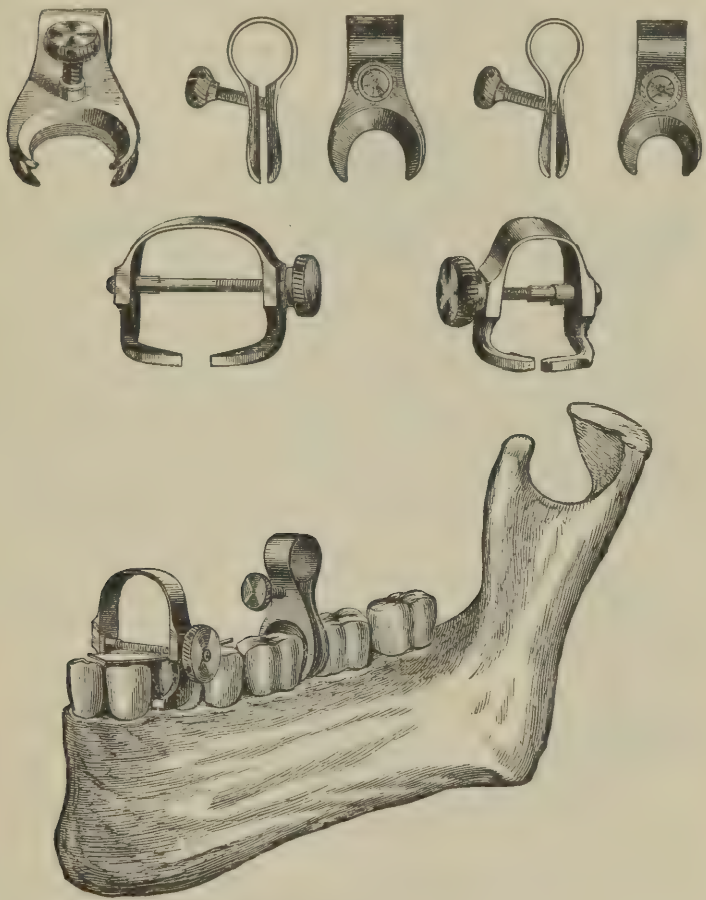


FIG. 360.

by it. This description applies to the front teeth, as it is not advisable to attempt the separation of the molar teeth in this manner.

Fig. 360 represents a set of the Jarvis Separators, by means of which adjacent teeth can be forced apart without delay or appreciable pain to the patient. This separator consists of a piece of steel, nickel-plated, bent upon itself, having the two ends formed to fit the outer

portions of the approximal surfaces of the two adjoining crowns. These jaws are forced apart by the action of the screw which passes through one and against the other. The compound forms consist of two wedges approaching or passing each other, and are applicable to the incisor teeth, the first forms being applicable to the bicuspid and molar teeth.

Figs. 361, 362, and 363 represent Dr. S. G. Perry's two-bar separa-

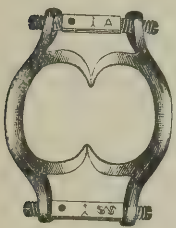


FIG. 361.

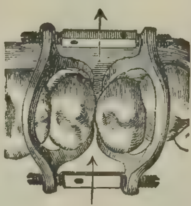


FIG. 362.

FIG 363.

tors, which are operated by a wrench with a double end, one straight and the other bent at an angle, to give greater facility for turning the bars in different directions. The shape of these separators permits the teeth to which they are applied to be approached readily from either side. The arrows on the bars indicate the direction they are to be turned to spread the separator. Fig. 364, 365, and

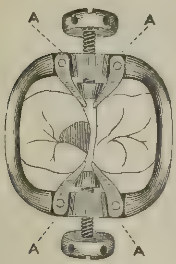


FIG. 364.

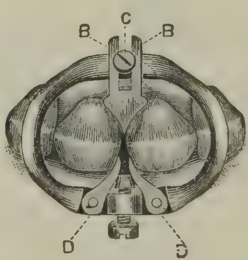


FIG. 365.

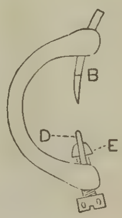


FIG. 366.

366 represent Dr. W. A. Woodward's separators, the blades of which act independently, which is an advantage when the teeth are irregular.

Fig. 367 represents Chase's Dental Wedge Forceps, by which wooden wedges can be forced between adjacent teeth for the purpose of separating them, and by the use of this appliance it is claimed that there is less danger of irritation and subsequent inflammation than by the method of driving a wedge with a hand-mallet.

Dr. Corydon Palmer recommends the following method of rapid wedging: A wedge made from a thin piece of wood or quill is first

introduced between the teeth to protect the gum. Next to the first wedge, a square, tapering one, of orange or boxwood, is introduced at the gum in such a manner as not to interfere with the view of the wall of the cavity, and which is permitted to remain during the operation of filling, being driven to hold the space gained by a broad wedge introduced by hand pressure or mallet force between the cutting edges of the teeth, its point being directed toward the gum. The separation is gradually accomplished, in order to allow the tissues to accommodate themselves to the pressure to which they are subjected. It is recommended that the rapid process for separating teeth be restricted to cases where but little space is required, and where the structures are soft and spongy. Fig. 368 represents a wedge cutter for removing the projecting portions of the wooden wedges.

FIG. 367.

After separating teeth by rapid wedging, the wooden wedges should not be permitted to remain between the teeth, when more than one sitting is necessary to complete the operation of filling, but removed, and the space maintained by cotton saturated with sandarach varnish, or by gutta-percha, until the next sitting.

There is a difference of opinion among many prominent and skillful

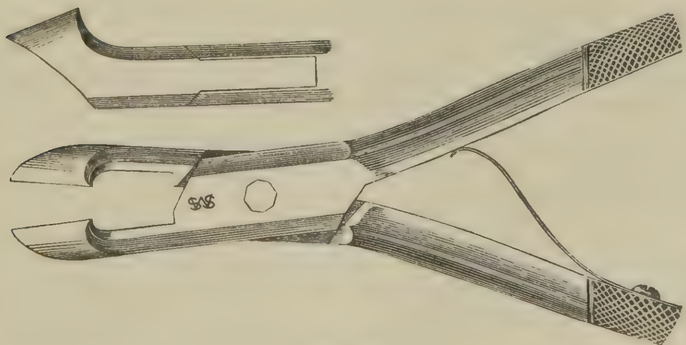


FIG. 368.

operators in regard to the permanent separation of the teeth, the advocates of contour fillings objecting to the removal of so much tooth-

substance without substituting for it a non-destructible substance, such as gold, while the advocates of the permanent separation method contend that self-cleansing surfaces, properly prepared, are preferable to the labor, pain, time, expense, and general strain for both patient and operator in perfecting contour work.

Dr. T. F. Chupein, an advocate of the permanent separation of the teeth, describes his method as follows:—

"The mode of treating the upper incisors and cuspids is indicated by the following diagram, Fig. 369.

FIG. 369.

"It will be noticed that there are semilunar spaces cut from the palatal surfaces of each tooth. These spaces are cut for the removal of incipient decay, for its anticipation, as well as to obtain room to fill when decay is deep-seated. To make these spaces without mutilating the outer faces of the teeth, we proceed as follows: Two

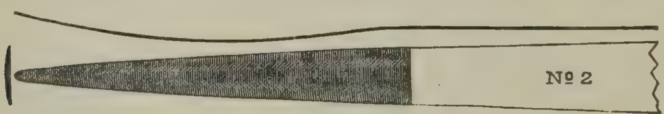


FIG. 370.

teeth are well wedged apart by the introduction of wooden wedges, floss cotton, or rubber, whichever seems best to the operator. When separated about the thirty-second of an inch or more, a thin disc is used on the dental engine. The Arthur disc, D, is about the proper size, and this is used on the palato-mesial and distal aspects of the teeth being operated on, and the cutting so shaped that the outer faces of the teeth are not encroached upon. After the enamel from these surfaces is removed, a curved file, (see Fig. 370), may be used to curve out the surface begun by the disc, or, what is still better, a small corundum point, mounted on the right-angle attachment of the dental engine, and applied between the two teeth to be operated on, the head of the patient being well thrown back, so that these surfaces may be

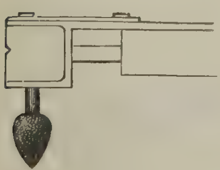


FIG. 371.

readily reached. Should either of the teeth thus separated need filling, the filling should be done at once, as more room is had now than if the teeth are permitted to fall back into their old places. When two are thus separated (and filled, if they need filling), two more are wedged apart and the spaces cut, as has been described."

Concerning the treatment of the bicuspids and molars, Dr. Chupein says:—

"These teeth are so concealed by the lips that even when pretty wide separations are made between them they present no revelation of their having been operated upon at all. To separate the molars and bicuspids we do not wedge them apart, as we recommend the incisors and bicuspids to be done (although it would be no detriment to do so), but we leave the teeth in the relation, one to the other, that we find them, and separate them, so as to leave a small point of contact near the gum margin. This point of contact, though minute, is sufficient to keep the surfaces that have been deprived of the enamel by the disc or file from again approaching each other, and also serves to protect the gum from being irritated by the impaction of food. Fig. 372 will illustrate this idea.

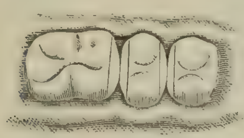


FIG. 372.

FIG. 373.

"It will be seen that the filed surfaces are entirely kept apart, and that though the tooth may change its position or turn in its socket (which is not likely) the cut surfaces would be still kept from close proximity. It also permits a free space, which is readily kept clean by simply rinsing the mouth. We fear that it is the careless manner in which this operation has been performed that has brought it into disrepute, and which, from this carelessness, has made many who tried the system abandon it as being ineffectual, when the fault lay more in the manner of its performance than in the integrity of the operation. Particular stress must be laid on the *non-removal* of this point of contact, otherwise the operation becomes ineffective. Indeed, if it is removed we consider that the operation would be worse than if nothing at all had been done. To make it entirely effective it should be done in anticipation of decay or when decay is in its first stages—when it has not, or scarcely has, pierced the enamel. If attempted later the very point of contact we wish to preserve will be encroached on by decay or completely destroyed by it. If in anticipation of

decay, the cutting need be done only from one tooth, and that from the mesial surface of the furthest back tooth. Fig. 373 will illustrate this.

"We would recommend that after the teeth are separated a waxed thread be passed through the separations down to the gum, and that this should pass the point of contact *easily* and with a *snap*, to indicate that the teeth are just held apart, but yet touch sufficiently that their relation one to the other should not have been changed. The thread or silk thus used should not be frayed. This would indicate roughened edges of enamel or too close contact. If the former, it should be polished or cut smooth; if the latter, the point of contact should be lessened so that the string will pass through readily and with a snap. We recommend, too, that the rubber dam be applied on these teeth after these separations are made. It will often *appear* that all decay has been removed. This deception is caused by the gloss left on the cut surfaces by the saliva, but when the dam is applied and the surfaces dried and critically examined, we can know for certain if all the disorganized tissue has been removed or not.

"We proceed to make these separations by arming the dental engine with a disc like that represented at Fig. 369 D. We cut the teeth through from their buccal to their palatal aspect, if in the upper, and from their buccal to their lingual aspect if in the lower jaw. We stop from time to time as we proceed, to see if we have not gone too far. When nearly down to the point of contact, near the gum, we stop with the engine and finish with a file having a round edge, like Fig. 374; or, in case of molar teeth, with a file like Fig. 375. When finished, the buccal aspects of the teeth have the appearance represented by Fig. 376, while the teeth viewed from their masticating surfaces are represented by Fig. 377.

"Should it be found necessary to fill the teeth thus separated, an easy approach to the cavity is had, and the fillings as well as the filed surfaces can be left highly polished.

"The class of teeth shown at Fig. 378 are such as we recommend to be treated as we have described, for they present broad surfaces of contact on their buccal, masticating, and palatal aspects, and are thus rendered more prone to decay from the ready lodgment of particles of food between them.

"The other class of teeth, represented by Fig. 379, rarely decay, because, as will be seen, they touch only by minute points of contact, and are thus not liable to decay. We do not recommend teeth of this form to be separated. If they decay they should be wedged apart and filled, and allowed to fall back in their old position. Decay in teeth of this class will generally be found above the point of contact,

toward the gum. Should permanent separation be attempted with teeth

Fig. 374.

Fig. 375.

Fig. 376.

Fig. 377.

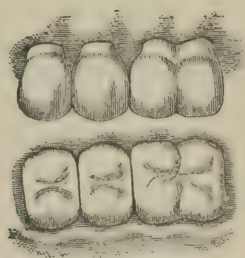


Fig. 378.

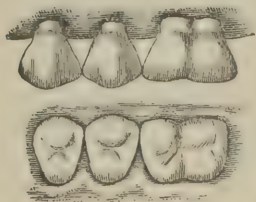


Fig. 379.

of this class it might prove ruinous, or if effective the teeth must, from their shape, be considerably mutilated and cut away, to prevent the

cut surfaces from again falling in close apposition. Judgment, therefore, must be used in the separation of the teeth, although, as we have said, the operation is comparatively simple.

"But whether the teeth be separated with cutting instruments or by pressure, the space should be sufficiently wide to enable the dentist to operate with ease, otherwise it will be impossible to remove the caries and fill the teeth in a proper manner."

TREATMENT OF DEEP-SEATED CARIES.

Filling teeth is one of the most difficult operations the dentist is called upon to perform; it often baffles the skill of operators who have been in practice many years. It is advisable only under certain circumstances, and when the operation is performed without due regard to these it must be productive of injury rather than benefit. It is the only certain remedy that can be applied for arresting the progress of deep-seated caries; but to be effective it must be executed in the most thorough and perfect manner. The preservation of a tooth may be regarded as comparatively certain when well filled, and with a suitable material, if it be afterward kept constantly clean. At any rate, it is not likely ever again to be attacked by caries in the same place.

On this highly important operation Dr. E. Parmly thus remarks: "If preservation is as good as a cure, this is as good as both; for the operation of filling, when thoroughly performed, is both preservation and cure. And yet it must never be forgotten that this assertion is true only in those instances in which the operation is well and properly done; and perhaps it is imperfectly and improperly performed more frequently than any other operation on the teeth.

"There are reasons for this fact, into which every ambitious and honorable practitioner will carefully inquire. Although the books are explicit on this point, I deem it sufficiently important to deserve a few additional remarks. The following considerations are essential, and, therefore, indispensable to success in this department of practice. *Firstly.* The instruments used must be of the proper construction and variety. *Secondly.* The material employed must be properly prepared as well as properly introduced. *Thirdly.* The cavity which receives the filling must be so shaped as to retain it in such a manner as to exclude not only solids, but all fluids, and even the atmosphere itself. *Fourthly.* The surface of the filling must be left in such condition as to place it beyond the reach of injury from food and other mechanical agents with which it necessarily comes in contact. *Fifthly.* The tooth thus filled should be free from pain and every known cause of internal inflammation."

It is important that the operation be performed before the disease

has reached the pulp-cavity; after this, the permanent preservation of the tooth may be regarded as more or less questionable. Still, under favorable circumstances the author believes it may, in the majority of cases, be performed with success. But, as the propriety and manner of filling a tooth after the pulp has become exposed will hereafter come up for special consideration, as well, also, as the operation of filling the pulp-cavity after the destruction of the pulp, it will not be necessary to enlarge upon these subjects at this time.

MATERIALS EMPLOYED FOR FILLING TEETH.—Among the articles which have been employed for filling teeth are gold, platina, silver, tin, lead; fusible alloys of tin, lead, bismuth, and cadmium; amalgams, gutta-percha, oxychlorid of zinc, oxyphosphate of zinc, and various preparations of the gum resins. Of these no single one can be said to unite all the requirements of a perfect material for filling, which may be enumerated: 1. Resistance to the mechanical action of mastication. 2. Resistance to the chemical action of the mouth. 3. Facility of introduction and consolidation. 4. Harmony of color. 5. Absence of all galvanic, chemical, or vital action upon the teeth or the general system. 6. Absence of all heat-conducting property. 7. Absence of shrinkage.

Gold Foil.—To the use of this material, when properly prepared, there is the least possible objection, perfectly answering the first, second, fifth, and seventh requirements, to a great extent the third, if in skillful hands, but deficient in the fourth and sixth. No better material is wanted for the operation. A tooth may be so filled with it as to secure, in almost every case, its permanent preservation. It should, however, be perfectly pure, be beaten into thin leaves, and well annealed by the manufacturer before it is used. When prepared in this manner, it may be pressed into all the inequalities of the cavity, and rendered so firm and solid as to be impermeable to the fluids of the mouth.

Although there may be no difference in the purity of the gold and the thickness of the leaves, yet a marked difference will be found to exist in the malleability and toughness of the foil of different beaters.

The art of preparing gold for filling teeth is an exceedingly nice and difficult one, and is believed to have attained greater perfection in the United States than in any other country; at least, this fact is so generally admitted that many of the most eminent European practitioners procure nearly all they use from America. (See process of manufacture in "Harris' Med. and Dent. Dictionary.")

The principal preparations of gold used for filling teeth are the non-cohesive, the cohesive, and the sponge or crystal gold.

Non-cohesive or Soft Gold Foil.—This is a preparation of leaf gold

which does not possess the property of cohesion to such a degree that the leaves can be firmly united on being pressed together with moderate force, and is introduced on the wedging principle, the cavity for its reception being made of such a form or shape as will retain the mass after it has been properly introduced and consolidated.

Non-cohesive gold foil is employed in different forms, such as the rope, the tape or ribbon, the cylinder, the pellet, and the mat or block.

The thickness of the leaves is determined by the number of grains each contains, and is designated by numbers on the books between the leaves of which they are placed after having been properly annealed. These numbers range from 3 to 240. A book containing a quarter of an ounce of No. 4 will have thirty leaves in it. Some dentists use foil varying in numbers from 4 up to 20, and even, of late, to 120, while others confine themselves to a single number. If but one number of the non-cohesive be used, 5 will perhaps be found better than any other. The author has used Nos. 4, 5, 6, 8, 10, and 15, but he prefers 4 and 5, and is decidedly of opinion that, in a large majority of cases, a better filling can be made with the first two numbers than any of the others. There may be cases in which higher numbers can be more advantageously employed; as, for instance, in cavities which are *very* large, and where the operation of filling has extended beyond the walls of the cavity, owing to the difficulty of securing a perfect adaptation.

Cohesive Gold Foil.—This is a preparation of leaf gold which possesses the property of cohesion to such a degree that the leaves readily and firmly unite on being pressed together with moderate force.

Although one or two others claim priority in the discovery of the advantages now derived from the use of cohesive gold foil, yet the credit is certainly due to Dr. Robert Arthur, as he was not only the first to demonstrate the applicability of this form of gold in filling teeth, but in a series of well-written articles* he overcame the objections which were at first urged against it, and proved that its great cohesive property rendered it a valuable adjunct in the preservation of the teeth. This form of foil is so cohesive that any number of pieces may be welded one to another; thus a part, or even the whole of the crown of a tooth may be built up with it. The same property may to a limited extent also be imparted to foil manufactured in the ordinary way of reannealing. This property is peculiarly valuable in many cases where it becomes necessary to build up a large portion of the crown of a tooth; but when it is used, instruments having ser-

*"A Treatise on the Use of Adhesive Gold Foil," 1857.

rated points are required, like those employed in the use of crystal or sponge gold.

Crystal or Sponge Gold has been employed by dentists for filling teeth for a number of years. The author has used it in a number of cases with very satisfactory results. Since the publication of the fifth edition of this work, the properties of crystal or sponge gold have been more thoroughly and extensively tested, and the result has fully confirmed the favorable opinion entertained by us with regard to its value. The author was acquainted with several of the most skillful operators in the United States who used it almost exclusively in their practice for several years, and saw fillings made by some of these gentlemen which, for beauty and solidity, he does not think could be surpassed. This form of gold has a spongy texture, being composed of crystals, and widely differs from foil or leaf gold. The crystals possess the property, when pressed firmly against each other, of welding and becoming as solid and almost as incapable of disintegration or crumbling as a piece of bullion or coin. This property enables a skillful manipulator to supply almost any loss which a tooth may have sustained, even to the building up of an entire crown. Still, it will never supersede the use of cohesive and non-cohesive gold foils, as there are many cases in which leaf gold can be used more advantageously and with more facility. Nor will the employment of it, in the opinion of the author, ever become universal, for the reason that more care and skill are required to make a good filling with it than with leaf gold, especially when the cavity in the tooth is difficult of access. Filling with crystal gold is more tedious than the same operation with ordinary foil.

Experiments have been made with *silver*, *platinum*, and *aluminium*, but with unsatisfactory results. They are less malleable than gold, and therefore cannot be made so thin; at the same time they have not the softness of tin, hence they work harshly under the plugger. An additional objection to silver is its liability to undergo chemical change, being in this respect greatly inferior to pure tin. Platinum, while it possesses indestructibility, in this respect being even superior to gold, is deficient in other properties as a filling material, as it cannot be welded with facility, is difficult to manipulate in the form of foil on account of its stiffness and harshness, and hence cannot be adapted and condensed in such form to the surface of a cavity. A form of platinum known as *platinum sponge* has been employed with greater facility than platinum in leaf form, but it requires skillful manipulation, and its cohesive property is readily destroyed by the slightest degree of moisture. Platinum has also been used in the form of foil coated with a considerable thickness of pure gold, and it is claimed

that by such a combination a denser filling can be made, and also one conforming to the color of the tooth in which it is placed. The peculiarity of aluminium, in this relation, is the impossibility of welding its leaves by pressure; even under the gold-beater's hammer it forms loose scales, which no annealing can make adherent.

Tin Foil.—This, when chemically pure and properly prepared, is less objectionable for filling teeth than most of the articles hereafter enumerated. Under favorable circumstances, if skillfully introduced, it will prevent the recurrence of caries. The greatest objection, perhaps, to the use of tin foil as a filling material is its softness and consequent inability to withstand the friction of mastication for many years. When used in cavities not so exposed it answers a good purpose as a filling material, as it is unalterable by reagents. Being an inferior conductor of heat it is tolerated in sensitive teeth in cases where a better conductor, such as gold, would not be. It is also regarded as valuable in soft teeth, and some regard it as possessing advantages over gold for filling in such teeth, and also in the temporary teeth, being easy of introduction and in accord with the tooth-structure. On account of the qualities referred to, tin foil is sometimes employed for lining cavities to be filled with gold. It is prepared as a filling material in the form of foil, the leaves varying in thickness from No. 4 to No. 20. The numbers from 4 to 10 are mostly used, and it is manipulated in the same manner as non-cohesive gold foil.

Lead is far more objectionable than tin, as it is more easily decomposed by the secretions of the mouth; its introduction into the stomach might be productive of serious injury to the general health of the patient. But, happily, the article is now seldom, if ever, used.

Amalgam, formerly known by the name of *mineral cement*, or *lithodeon*, is usually composed of about equal parts, by weight, of pure tin, silver, and varying proportions of zinc and platinum—and sometimes gold and copper—the zinc, about one to three per cent., constituting a most important element in controlling shrinkage and preventing oxidation. The gold is not especially valuable, and when used in an amalgam from one to four per cent. is sufficient. These metals are melted in a crucible and poured into ingots, which are then cut up with a file into filings. These filings are mixed, after the cavity in the tooth is prepared for the filling, with about thirty-three and one-third per cent. of distilled mercury, and incorporated to the consistency of a thick paste. The mass is then thoroughly washed with alcohol, to which is added a few drops of a strong solution of chloride of zinc. The excess of mercury is then removed by twisting the mass in a piece of chamois skin or strong muslin. It is also recommended to press

the mass quite thin, after it is removed from the chamois skin, with a strong pair of flat pliers, in order to remove still more of the mercury. Caution should, however, be used to avoid pressing out too much mercury. The mass, when introduced, should be about the consistency of ordinary putty. The cavity should be prepared with as much care as for a gold filling, and moisture prevented from coming in contact with it. When the cavity approaches near to the pulp, some non-conducting substance, as Hill's Stopping, should be applied between the amalgam and the bottom of the cavity. After the filling has become sufficiently hard, its surface should be carefully finished by filing and burnishing.

Dr. Bonwill gives the following directions for working amalgam composed of silver, tin, and gold; from five to seven per cent. of the latter he considers sufficient:—

"As soon as the first piece of alloy is inserted, a wad of bibulous paper (Japanese) as large as the cavity is placed thereon, and an oval-pointed steel instrument is pressed upon it with great force, to crowd out the superabundant mercury. Go on adding alloy and more paper until the cavities are crowded full from cuspid to molar, leaving no intervening space. Direct pressure is not as efficacious as rubbing the amalgam in with a burnisher over the paper, which drives the mercury out at all points. No rough-faced instrument should be used; smooth burnishers and oval-faced only, on the same principle as in rubbing in gold by the action of the mechanical mallet. When you have reached nearly the proper fullness, use the flatter burnishers entirely, to not only add the alloy, but to be sure that the mercury is carried to the edges. To do this you must not lose a moment; and the alloy should not have too much gold in it, or you cannot undertake so much at one sitting."

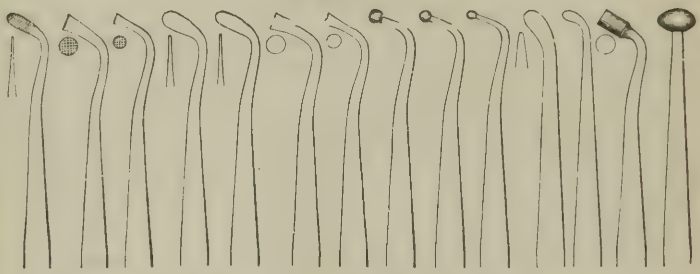
Describing the operation of filling with amalgam the superior cuspid decayed on its distal surface, with the first and second bicuspids on the anterior distal, and grinding surfaces gone so far as to leave nothing standing but the buccal and palatal walls, and to this add the first molar with its anterior wall, crown, and distal surfaces as seriously involved, the same writer continues:—

"By the time you have gotten all the cavities full, you must commence at once to divide between each and contour.

"It will be found that when the opposite teeth are made to antagonize with it, great care must be used to keep from dislodging any portion of this large mass; therefore, before the division on the approximal surfaces is made, see that the articulation is absolutely correct. Then with a broach with small point turned, scratch away all the cervix until the tool reaches from both buccal and palatal surfaces,

and the divisions are clear to nearly the grinding surface. Now, with a very thin knife or saw you can carefully divide the fillings, to make

FIG. 380.



2 3 4 5 6 7 8 9 10 11 12 13 14 15

16 17

each tooth distinct. In this proceeding great care must be exerted or the contour will be broken. When this has been done, shape with proper instruments, leaving all the grinding surface in contact as broadly as possible, so that when the teeth go back again to their positions from which the gutta-percha had moved them, the food cannot wedge down between them. Where cavities are obscure on approximal surfaces, get the alloy as nearly in place as you can, and a wad of paper will be sure to force it down. Besides those cases with more or less walls for support, in those where much of the cusps of either wall is gone the alloy can be added and compressed easily and surely. Entire or partial crowns can be secured in a few minutes. Be sure that the alloy is not allowed to remain projecting over the free margin of the contour before the patient leaves. Then but little dressing of the contour is necessary when the operations are filed and finished."

Fig. 380 represents a set of what are known as Arrington's amalgam instruments. Amalgam becomes hard by the crystallization of the mass and the evaporation of the mercury; hence, without a well-prepared form is used, and great care exercised in its amalgamation and introduction, a filling of this material may either contract or become porous; and when the latter is the case the oxidation extends to the tooth-structure, which becomes, as a consequence, discolored.

Amalgams, unlike the plastic gutta-percha and zinc preparations, do

not adhere to the walls of the tooth-cavity; hence, in their use it is necessary that attention should be paid to the form of cavity into which they are to be introduced; and as they are often employed for filling cavities of a shallow form, and with frail walls, under-cuts and dovetails are required for the retention of such fillings. From the tendency of the amalgams of mercury to assume a spheroidal shape and separate from the margins of a cavity, sharp angles and pits are objectionable. The addition of palladium to an amalgam may prevent such shrinkage, but adds to the discoloration, and the rapidity of its setting is such as to evolve a sufficient amount of gas to cause an explosion with emission of light. Such an accident may be avoided by gradually adding the palladium powder to the compound and using very small pieces for introduction, and their rapid insertion, each piece being well compounded as it is added to the mass. It is claimed that while the surface of a palladium amalgam changes to a black color, it does not stain the tooth-structure, and that it is the most durable of the amalgams. An excess of silver will also cause an amalgam to blacken and stain the tooth-structure. Silver and copper control the change in form, as the solid particles of copper which remain have an amalgamated surface only, which prevents the change in form common to a homogeneous mass. Platinum imparts toughness and edge-strength to an amalgam. Gold makes an amalgam composed of tin, silver, and mercury unclean, although an amalgam of pure gold and mercury alone is white and clean, but is not adapted for a filling material.

A better class of amalgams now in use appears to change bulk to a less degree and to preserve their light, silvery color much better than the older forms; hence, the former objections to this filling material appear to have, in a great measure, been overcome. The ease with which amalgam fillings can be introduced no doubt often leads to carelessness in the manipulation of this material, but it should be remembered that to obtain the best results from it the cavity in which it is placed should be as carefully prepared as for a gold filling, and also that perfect dryness is essential to its adaptation and durability.

There exist some differences of opinion concerning the necessity for washing amalgam, prior to its introduction, with alcohol and other fluids, some contending that by so doing it is impossible to remove all the moisture in time for its insertion. Sufficient mercury should be allowed to remain in the mass as will permit of its being manipulated without crumbling, and when it is inserted over a sensitive surface or in proximity to the pulp of a tooth, some intervening substance, such as Hill's Stopping or oxyphosphate of zinc, should be placed between the sensitive surface and the filling.

It is claimed that continuous pressure with the burnisher upon the surface of an amalgam filling during its setting will prevent its tendency to separate from the walls of the cavity, and insure better results from its use. It is also very necessary that the margins of amalgam fillings should be well defined, as, owing to its brittle nature, thin, overhanging portions are liable to break away, leaving imperfections which may soon prove injurious to the filling. After an amalgam filling has become hard (and during this hardening process the patient should be warned against masticating upon it) the surface should be as carefully prepared and polished as that of gold filling.

The objections, therefore, urged against amalgam are, that it oxidizes and blackens; that the tooth-structure with which it remains in contact becomes discolored; that it contracts in hardening, allowing the secretions to make their way around the filling. Of late years it has been urged that it is incompatible with tooth-structure, and that the mercury might act injuriously on the system. These objections are characteristic of most of the amalgams now on the market, although in a few notable exceptions they have been almost entirely overcome; but there is no good reason why amalgam should be incompatible with tooth-structure, or that the small amount of mercury imprisoned in this alloyed mass should possibly produce any mercurial effects. There is good reason, therefore, for believing it to be, in these respects, perfectly inert. The use of amalgam is *contraindicated* in all teeth which can be filled with gold—in the front teeth on account of its color, and in pulp-cavities on account of the difficulty of introduction into small canals. Various opinions are held as to the indications for the use of amalgam. In our own opinion it is one of the most valuable materials for some operations, as, for instance, in cavities so difficult of access as to render the introduction of a perfect gold filling doubtful, and where the operation would be long, tedious, and difficult to both patient and operator, were gold used. Amalgam is also employed by some for filling roots, on account of the ease and facility with which it can be carried to the end of the root-canal.

Fig. 381 represents some forms of amalgam Carriers and Fillers.

Several of these instruments are constructed with fixed points, covered by a tube, which projects to form a cup for the amalgam, and recedes so that the points work through as Pluggers to force it into the cavity, one being half-curve, another double-end, giving two angles, and another straight. One has a fixed tube with spring plunger to force in the amalgam. A Loadstone Carrier and Plugger has a double end, one point of which is so prepared as to attract amalgam, which will adhere to it while being conveyed to the cavity in the tooth; the reverse end is made as a Filler.

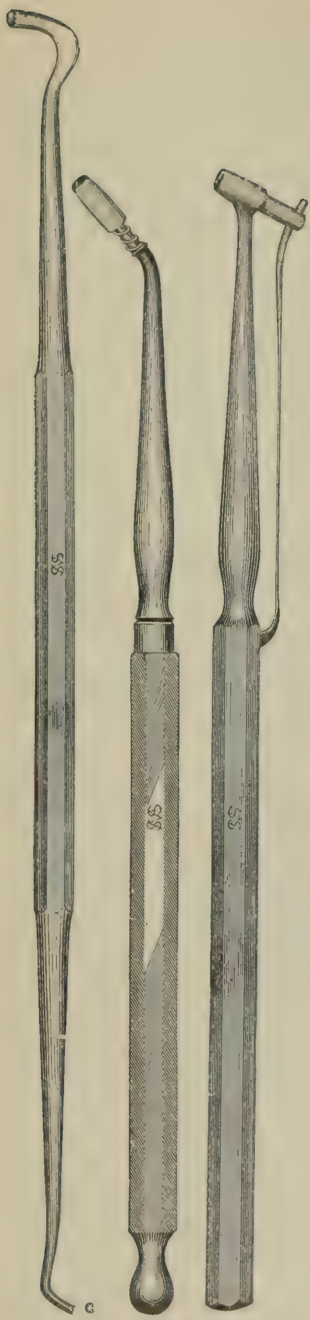


FIG. 381.

Fig. 382 represents a Mercury Holder for convenient preparation of amalgam.

Fig. 383 represents a set of Weston's Amalgam Pluggers.

Gutta-percha and Hill's Stopping.—Gutta-percha is an excellent material for temporary fillings. It may be made harder, whiter, and less contractile by incorporating with it some very fine powder of feldspar, silex, lime, or magnesia. A very excellent preparation known as *Hill's Stopping* is made by mixing gutta-percha with as much of the following powder as it will hold without

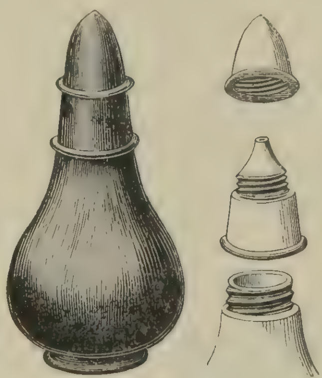


FIG. 382.

becoming brittle; quicklime, two parts, very fine quartz and feldspar, one part each. Prepared gutta-percha and Hill's Stopping are introduced in small pieces by first warming on a porcelain or metal-slab, over an alcohol lamp, until they become plastic enough to be readily pressed into the cavity and to adhere to its walls. As soon as the cavity is filled, an instrument having a condensing point large enough to cover the entire surface of the filling should be applied and kept in position until the mass has become cool.

Fig. 384 represents Dr. Howe's Thermoscopic heater for scientifically softening gutta-percha, which is described as follows:—

"The Heater (illustrated natural size) is made of steatite, which absorbs heat slowly and retains it a long while. A non-conducting

FIG. 383.

handle of wood allows the Heater to be held over the flame, as shown. In a small recess a quantity of metal, A, fusible at 212° F., is placed. When this melts, the Heater may be set on the bracket-table, and gutta-percha pellets, 1, 1, will be found to be safely and suitably softened for use. Low-heat pellets, as 2, 3, or 4, are placed at various distances from A, according to their softening points, to insure their being heated to exactly suitable temperatures. For high-heated pellets, A is melted, poured out, and the 230° F. button B substituted. The Thermoscopic Heater thus enables the dentist to heat gutta-percha of whatever grade to its proper softening point with the scientific certainty of uniformly producing suitable plasticity without danger of injuring the sensitive material, which is so frequently burned, smoked, or otherwise impaired by the crude methods in common use, meeting every need."

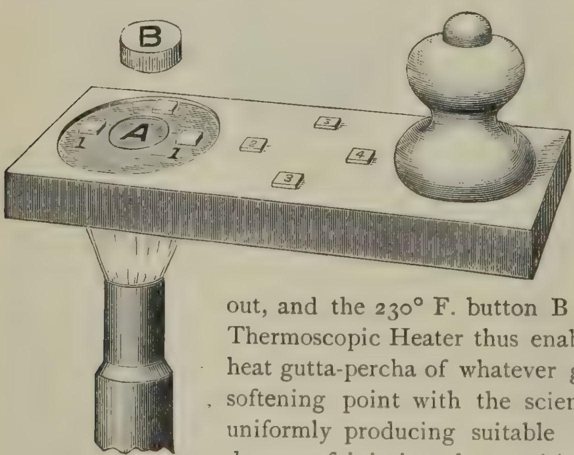


FIG. 384.

The preparations of gutta-percha now used for filling materials possess different grades of plasticity, so that a filling may be commenced with one that softens at a low temperature, and finished with

another which requires more heat to render it plastic, and hence becomes harder. For cavities situated on the approximal surfaces of the teeth and extending below the margin of the gum, gutta-percha preparations appear to answer a good purpose in resisting the dissolving action of the acid from the inflamed gum. When the gutta-percha preparation is made plastic enough to adhere to the walls of a cavity, by passing it through the flame of a spirit-lamp, care is required that it should be evenly heated and not burnt. By using the lower grade over sensitive portions of a cavity less pain is experienced from the heat, and after the cavity is filled with the higher-grade material the surplus can be removed with thin steel or platinum spatulas heated to the required degree, and the surface made smooth by passing over it a burnisher. Chloroform applied to the surface of a gutta percha filling will give a smooth finish, but may render such a surface less durable on account of its dissolving action.

Fig. 385 represents a set of Dr. W. A. Bronson's gutta-percha instruments.

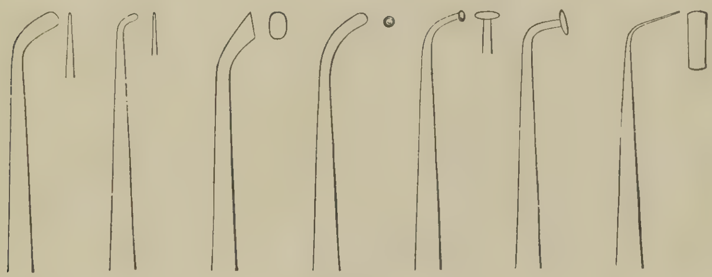


FIG. 385.

Zinc Preparations.—A mixture of chlorid of zinc and oxid of zinc has been much used under the various names of *oxychlorid of zinc*, *os-artificial*, *osteo-dentine*, *osteo-plastic*, mineral paste, etc. Quackery has seized it with eagerness, and plastered up many teeth with a mortar even more conveniently used than amalgam. Although in some few cases it may resist the action of the secretions of the mouth, it will not answer for a permanent filling. The friction of mastication soon destroys it, and in approximal cavities it frequently crumbles away in a few weeks or months. Still, as a *temporary* filling, it may, if employed with caution and judgment, be found useful, and for certain cases very valuable. It has been used with success for filling the pulp-cavities of the teeth. It has also been applied to partially exposed nerves, and in some favorable cases successfully, but its use for such a purpose is very uncertain, as the escharotic action of the zinc chlorid may produce death of the pulp. In the combination of the

oxychlorid ingredients the oxid of zinc is usually mixed with some siliceous substance, to increase the hardness, and the chlorid of zinc is diluted with water. When the powder and liquid are combined a cement results, which forms hydrated oxychlorid of zinc by the taking up of some of the water as a base. Some prefer mixing the oxychlorid in the form of a thin paste, and after adapting it carefully to the bottom and sides of the cavity, or over a sensitive surface, to complete the operation with a paste of thicker consistency. A warm burnisher will hasten the setting of the oxychlorid and apparently increase its hardness. The application of talc (soapstone) in the form of a properly-shaped point, which may be heated, or in the form of powder, appears to improve the surface of such a filling by rendering it less permeable to moisture. On account of the oxychlorid preparation being acted on by weak acid and even alkaline solutions, it cannot be depended upon for a permanent filling material, and will frequently dissolve away in a few weeks or months, especially if introduced near to or beneath the margin of the gum. It often answers a good purpose when applied to sensitive dentine, but, like the chlorid of zinc, one of its ingredients, its application causes considerable pain for a short time. It has also been employed for bleaching discolored dentine, and as an interposing substance between a thin wall of cavity and darker, but more durable, filling material, such as amalgam.

Of late years various preparations, known as *oxyphosphates of zinc*, have been introduced, composed of the basic oxid of zinc and glacial phosphoric acid. One of the zinc preparations is composed of the nitrate of zinc and phosphoric acid. The oxyphosphate preparations are preferable to the oxychlorids on account of their being less irritant to the pulp and more durable, especially when placed about the necks of the teeth. They have also the advantage over the oxychlorids of greater hardness, but it should be remembered that all of the zinc preparations are liable to be dissolved by the fluids of the mouth, and hence are not so reliable for temporary fillings as gutta-percha, especially the form known as Hill's Stopping, particularly where such fillings extend beneath the margin of the gum to the cementum.

The oxyphosphates mix less readily than the oxychlorids, and require more care in the combination of the powder and liquid. If mixed too thin, a sticky, unmanageable mass results, and if too thick the mass will crumble in pieces; it is therefore recommended to so prepare it that it may be rolled between the thumb and finger without adhering to them, or, on the other hand, crumbling to pieces. On account of the oxyphosphate setting very rapidly, the cavity should be ready to receive it before it is mixed, by being free and protected from moisture by the application of the rubber-dam.

Like the oxychlorid, it is necessary that the surface of a filling of this material should be protected from moisture for some minutes after its introduction, and the same substances may be used to coat over the surface, as in the case of the oxychlorid. Unlike the oxychlorid, however, a warm instrument cannot be employed to hasten its setting. A number of forms of these cements are in use under the names of those originating them. One form, known as Poulson's, is the pyrophosphate of zinc, the pyrophosphoric acid being in crystals, which require to be melted in a platinum or porcelain spoon held over a spirit lamp, care being taken that ebullition does not occur. When reduced by heat to the consistency of glycerin, it is dropped upon a warm porcelain slab, and is ready for introduction into the cavity. Exposure of this preparation to the air causes its deterioration, hence it should be kept in hermetically sealed vessels. Some of these plastic zinc preparations appear to be much less soluble in some mouths than in others, and considerable importance is attached to the manner in which they are mixed and inserted into the cavity.

In using any of these preparations the cavity is prepared as usual; then a small quantity of the liquid (either the chlorid of zinc or the phosphoric acid) is dropped upon a piece of glass or porcelain, and enough of the powder (oxid of zinc) added to make a paste so thick that the surface will not appear watery. The cavity having been perfectly dried and protected from saliva, the material is quickly introduced, after which it is kept free from moisture for ten or twenty minutes. When sufficiently hard, the surface is finished by scraping and polishing. The longer the surface is kept dry, the harder these materials become. Coating the surface with sandarach varnish (or gutta-percha dissolved in chloroform, or melted wax) will afford protection for some time.

In all cases where these preparations are introduced near a pulp, or as a capping over exposed pulps, the cavity should always be previously wiped out with a solution of gutta-percha and chloroform, to prevent the escharotic and irritant effect.

Fig. 386 represents platinum points for oxychlorid and oxyphosphate filling.

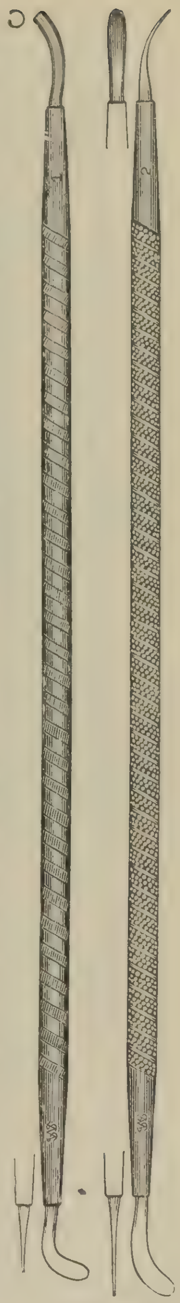


FIG. 386.

Fig. 387 represents the agate burnisher, which is considered by some to be superior to any other burnisher for surface finishing of oxychlorid and oxyphosphate fillings.

Fig. 388 represents the points of different

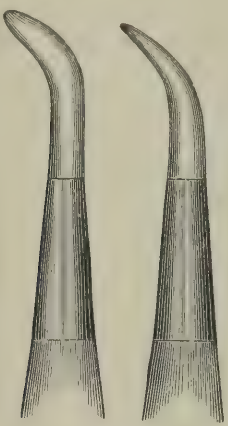


FIG. 387.

forms of spatulas for mixing the zinc preparations, which is conveniently done on a porcelain palette, such as is used by artists.

Fig. 389 represents a common form of mouth mirror, of which both plain and magnifying

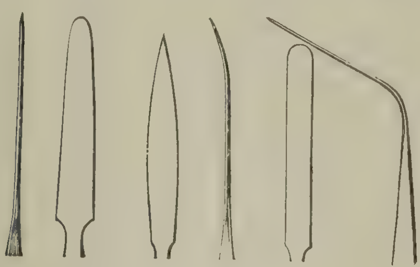


FIG. 388.

are used in examining the teeth. Dr. Maynard, of Washington, made an improvement in mouth mirrors, by substituting pebbles for glass, which more clearly reflect the objects they picture.

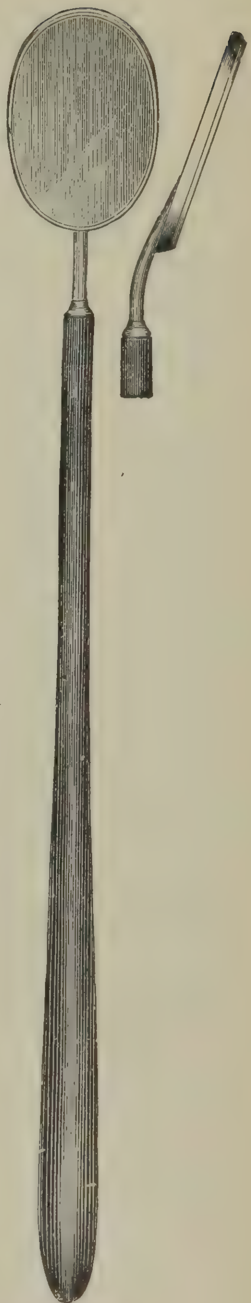


FIG. 389.

Fig. 390 represents reflectors for attachment to rubber-dam clamps, so that while providing a strong light, both hands of the operator are left free for manipulation. They are useful in operations upon posterior cavities in molars. By means of a ball-joint the mirror can be adjusted to concentrate the light upon the cavity or any portion of the mouth required.

Instruments known as stomatoscopes have been devised for the purpose of obtaining a perfect light for operations on the distal surfaces of molars and bicuspids, and are found to be especially useful when the sky is cloudy and for night work. Such instruments as the Grohnwald and Beseler stomatoscopes, which are capable of being so adjusted as to throw light to any part of the mouth necessary in filling teeth may be used. Dr. C. F. W. Bodecker asserts that by aid of a stomatoscope he was enabled to see up to near the apex of the pulp-canal of a palatal root of a first upper molar, the cavity being on the distal and grinding surface.

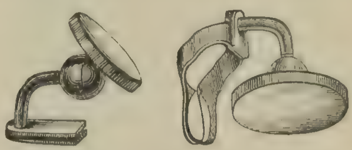


FIG. 390.

The electric light has also been utilized for the same purpose, and also for examinations of the throat, and even of the stomach. Mr. E. T. Starr, of the S. S. White dental establishment, succeeded in obtaining highly satisfactory results in this direction. His instrument consists of a lamp formed of a delicate glass bulb, from which the air has been withdrawn and as nearly a perfect vacuum created as possible. The bulb varies in shape, being spheroidal, flat, and compass-shaped, and also cylindrical, with a conical termination. Through the thin wall of the lamp run the conducting wires, connected by a carbon arc, on which the electricity centers, and which thus becomes the place of light. The glass lamp is very small, the cylindrical-shaped being scarcely half an inch in length, and with a diameter much less than that of an ordinary lead-pencil. The compass-shaped lamp is about one-quarter of an inch thick, and has a diameter of three-quarters of an inch to an inch, while the spheroidal is scarcely larger than a good-sized pea. The lamp is attached to a handle from seven to nine inches long and about half an inch thick, through which run the wires connecting with the battery. The intensity of the power and the brilliancy of the arc of light can be regulated by moving along the handle a ring which connects with the wires. The handle has several joints, and its position can be arranged so as to adapt it to the shape of the cavity it is to illuminate. Mirrors can also be fastened to the lamp, and light reflected to places where the lamp cannot be introduced. To prevent the too

great radiation of heat and the diffusion of light, the lamp may be partially covered with a hard rubber or gutta-percha case. When the lamp is placed in the mouth of a patient, every portion of the throat, even to the lowest parts, and every recess of the upper places can be plainly seen. Placed behind the teeth, the intense light renders not only the teeth, but even the gums above, highly transparent. If the teeth are good and free from caries, no lines will be visible, but the presence of a filling or the beginning of caries may at once be seen. When the lamp is placed within the mouth, and the lips are closed, the entire front structure of the mouth is brought to view. No unpleasant sensations are experienced, even in cases of protracted use.

Fig. 391 represents the "Electric Mouth Lamp," or "Stomatoscope."

The electric mouth lamp will be found an invaluable assistant to the dentist in diagnosing lesions of the teeth and associate parts, especially in those obscure cases where, although there are unmistakable symptoms of serious pathological disturbance, careful examination with the appliances heretofore in vogue fails to discover the exact location of the trouble. Sound teeth are sometimes needlessly sacrificed in fruitless endeavors to find the seat of neuralgic pains for which, owing to the insufficiency of the means of diagnosis, no satisfactory cause can be established. The electric mouth lamp illuminates the oral cavity so brilliantly that any departure from normality, whether it be a hidden cavity of decay, an unsuspected dead pulp, or even the slight thickening of the tissues which is the precursor of decay, is unerringly detected.

This apparatus will also be found very useful in the operating room in other directions. In the preparation of inaccessible cavities it is often difficult to tell when the excavation has proceeded far enough, but the electric mouth lamp will show at once whether all the disintegrated tooth-substance has been removed.

In use the lamp is placed behind the object to be illuminated—that is, so that the object is interposed between the lamp and the eye of the observer. Thus, in examining the teeth the lamp is placed within the arch, so that its light falls upon the lingual or palatal surfaces of the teeth, while the eye of the operator is directed to the labial or buccal surfaces. So lighted, every portion of the teeth and gums is thrown into strong relief; the sound teeth will appear translucent and with no variations in texture, but a dead tooth will be at once detected by its opaque or dark appearance, even although to ordinary observation its color would indicate vitality. A cavity of decay, or any foreign substance about the teeth, will show as plainly as a spot upon a window-pane. A healthy root will not be distinguishable from the

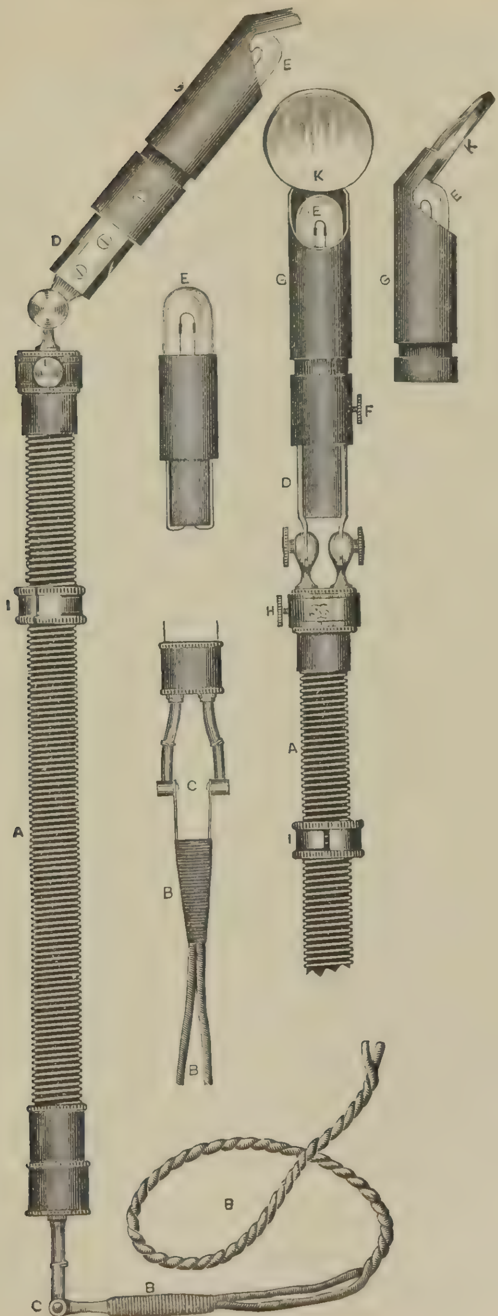


FIG. 391.

membrane surrounding it; but caries of the pulp-canal or any thickening of the tissues will be brought out by the illumination.

For the examination of posterior cavities in teeth a mirror is attached to the guard in front of the lamp globe, forming a perfect apparatus for the purpose.

It has been found impossible, so far, to make the lamps of exactly equal power, but the variation is not great. To develop their full capacity requires about 3½ to 4½ volts—say the current from two to three cells of a Bunsen battery. The cells of the battery supplied with the electro-magnetic mallet are excellent for the purpose, or three or four cells of any bichromate battery will answer.

The circuit should be broken occasionally during a prolonged examination, and also whenever the lamp is not in use, to prevent its becoming so hot as to be unbearable in the mouth.

For the examination of posterior cavities a mirror, set at an angle

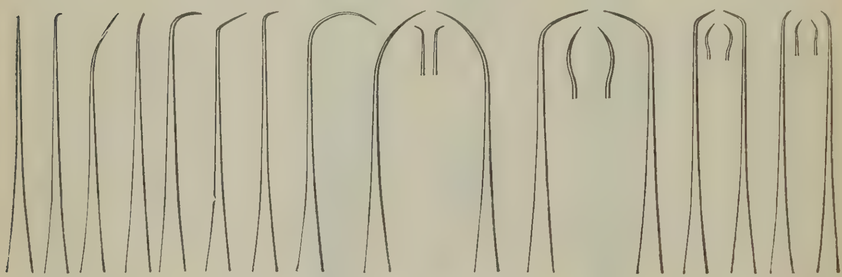


FIG. 392.

of 45 degrees, is attached to the end of the guard. With the mirror attachment the electric mouth lamp forms a perfect laryngoscope.

INSTRUMENTS FOR FORMING THE CAVITY.—Fig. 392 represents a set of instruments called "Explorers," useful for examining the teeth to determine the presence of caries. For the removal of the diseased part of the tooth and the formation of a cavity for the proper reception and retention of a filling, a variety of instruments are required, which should be constructed of the best steel and so tempered as to prevent them from either breaking or bending. Their points should be so shaped that they may be conveniently applied to any part of a tooth, and made to act readily upon the portion which it is necessary to remove.

The instruments employed for this purpose are chisels, excavators and burs. Fig. 393 represents some of the many forms of excavators in use. They may be formed either with handle and point in one piece or fitted to separate handles made of wood, ivory, pearl, or cameo, or be made to

fit into one common socket handle, or for use in the engine. The introduction of cone-socket handles has supplanted all other styles of

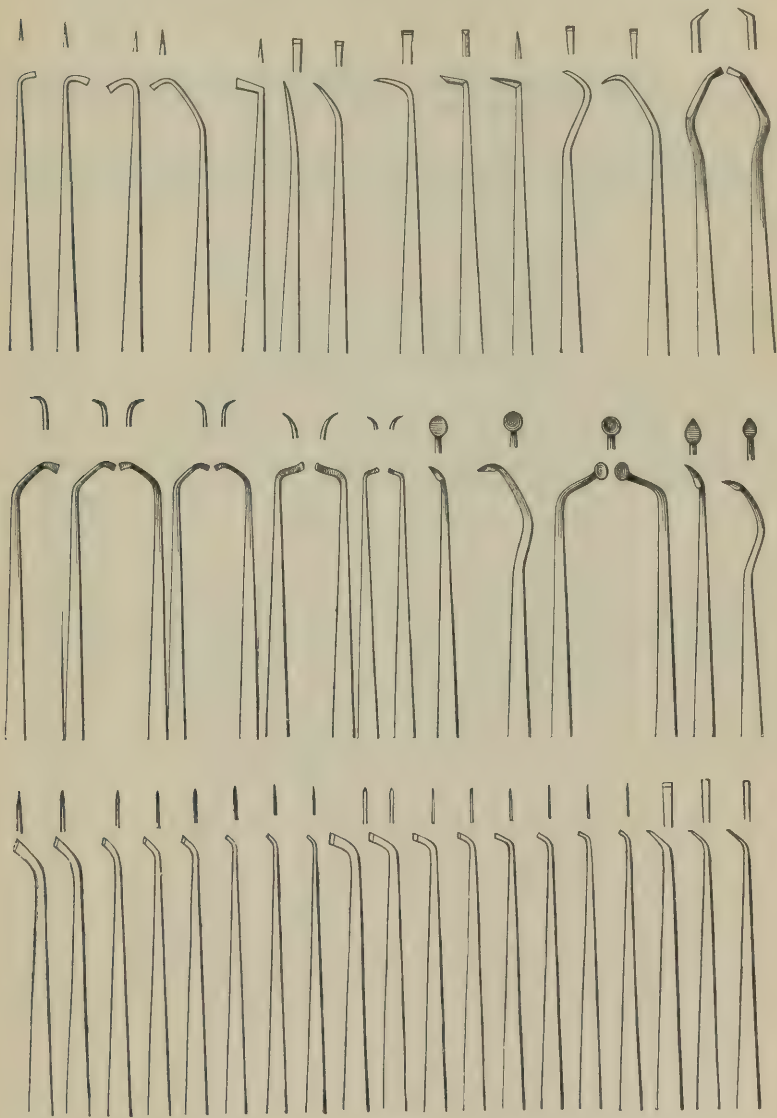


FIG. 393.

socket-handle instruments. These handles are made of steel, nicely engraved and nickel-plated. Fig. 394 represents such instruments.

Fig. 395 represents the form of plyers for screwing the points into the cone-socket handles.

Fig. 396 represents Dr. W. C. Head's approximal surface excavators, intended chiefly for use in preparing cavities between the upper

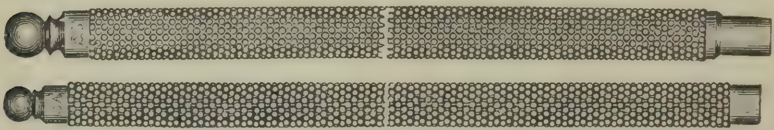


FIG. 394.

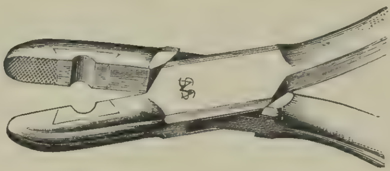


FIG. 395.

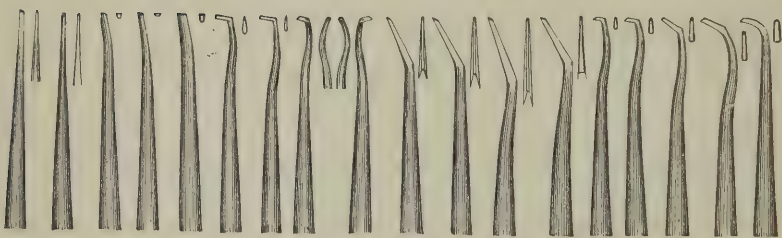


FIG. 396.

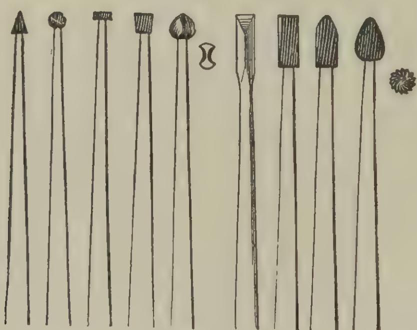


FIG. 397.

front teeth, working from underneath, but are also useful on bicuspids where compound cavities are to be formed for contour fillings.

The flat and bur-headed drills represented in Fig. 397 are very useful for enlarging the orifice of a cavity. Fig. 398 represents a

revolving head bur and drill socket, which carries burs and drills of all sizes. The clutch is operated by throwing forward or backward the section of the socket at A.

The use of excavating burs, by means of the dental engine, has

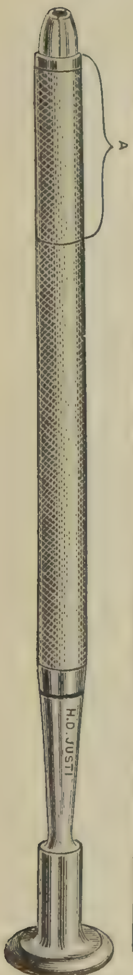


FIG. 398.

FIG. 399.

almost supplanted the separate-handle drills. Fig. 399 represents a variety of forms of excavating burs and drills for use with the dental engine.

The Dental Engine is a valuable invention, for which the profession is indebted to Dr. Morrison, of St. Louis, and by means of which

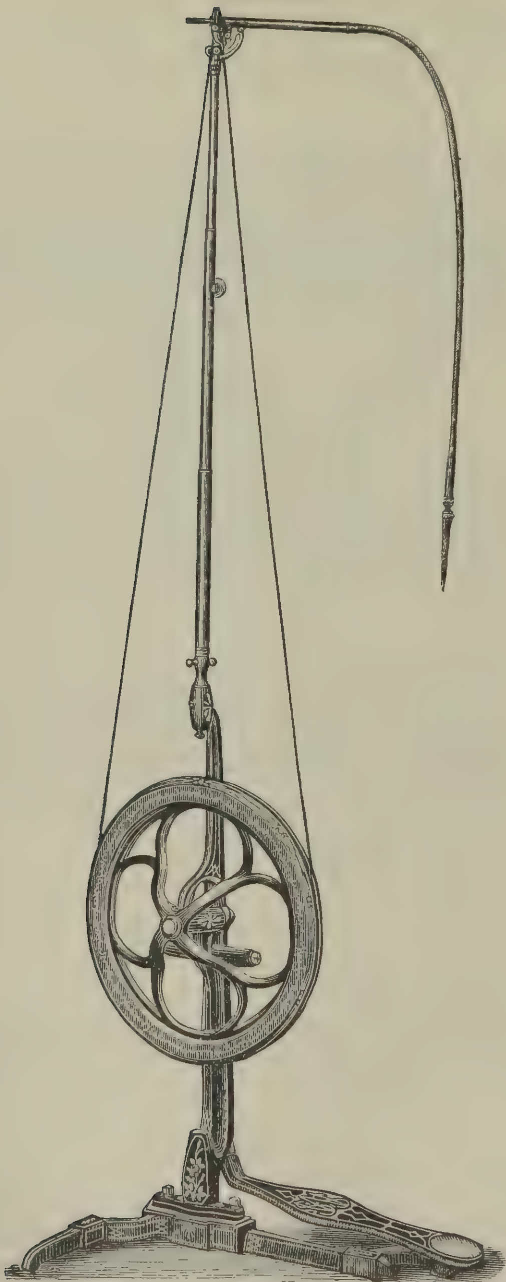


FIG. 400.

instruments, such as burs, drills, discs, condensing points, burnishers, wood-points, etc., can be rapidly revolved and effectively employed.

Figs. 400 and 402 represent two dental engines, a number of which are now in use.

Hand-Pieces, straight and angle, of various designs, and which hold burs, discs, points, etc., are attached to the cable or arm of the dental engine. Some of these hand-pieces are represented by Fig. 401. The cable of a dental engine can be attached to a water-motor or to an electric wire, both of which make efficient motive power.

Fig. 403 represents a rubber bulb chip syringe, for blowing the cuttings and dust from cavities in teeth by means of cold air.

Fig. 404 represents an elastic bulb syringe for cleansing cavities. The bulb is first compressed, and the point is then inserted under water, when it fills itself.

Enamel chisels of different shapes, and gouges, are also very valuable instruments for the preliminary operation of opening large cavities or cutting off sound enamel or dentine whenever necessary.

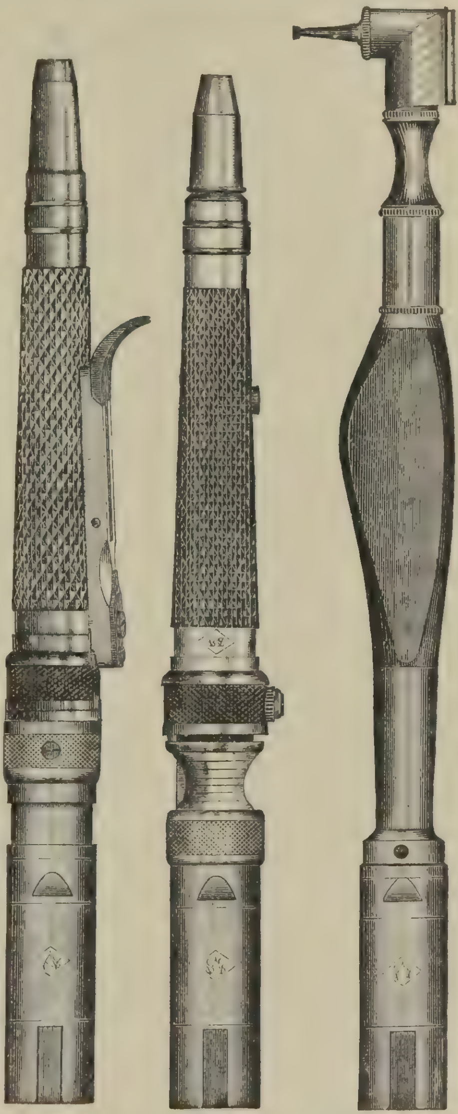


FIG. 401.

But the cavity can seldom be completed with such instruments. After it has been opened and the orifice made sufficiently large,

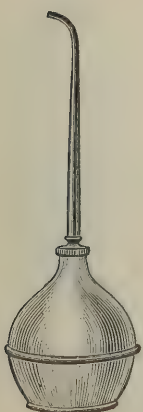


FIG. 403.

FIG. 404.

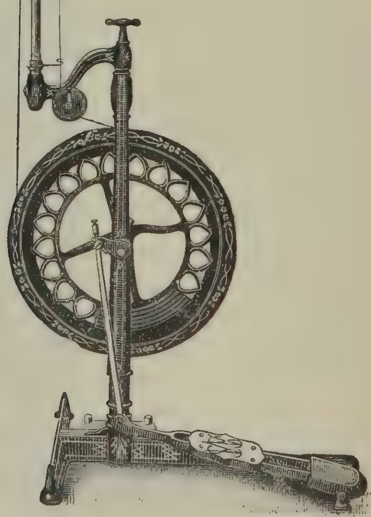


FIG. 402.

it should be finished with excavators (Fig. 393) and burs (Fig. 399) properly adapted to the purpose; in fact, in the majority of cases it should be wholly formed with instruments of this sort.

Excavators, shaped like those represented in Fig. 393, have been found by the author to be as well adapted for the removal of caries as any which he has ever employed. There should be several sizes of each shape; also duplicates of each instrument, to prevent delay in case of accident while operating. As the proper formation of the cavity greatly depends on having suitable instruments, every operator should be provided with a large supply of bur drills and excavators, so that he may never be at a loss for such as the peculiarity of any case may require. He should also have the material, and know how, in an emergency, to point his own excavators. For this purpose he will need a lamp, a small anvil and hammer, a set of fine-cut files, such as are used by watchmakers, and an assortment of steel rods of various sizes and of the best quality. It is not our purpose to give specific directions for working steel, but we would offer two cautions: first, small points quickly become brittle by hammering and need frequent annealing; second, steel is greatly injured by raising it to a full red or white heat. A very fine temper may be given, after shaping the point, by heating to redness and suddenly plunging it in wax or tallow.

As excavators must be kept very sharp, an oil-stone should be constantly at hand. The Arkansas, Hindostan, or Superior stones are superior, for this purpose, to all other varieties, on account of their hardness, fineness, and sharpness of grit.

Manner of Forming the Cavity.—The preparation of the cavity in a tooth for the reception of a filling is a very essential part of the operation, and, though usually the easiest, is sometimes attended with much difficulty. The removal of the diseased part is sometimes all that is necessary preparatory to the introduction of the gold, but in the majority of cases the cavity must be so shaped as, when properly filled, to retain the filling in place.

Where the orifice to a cavity is small and contracted it should be enlarged, by means of a bur drill, sufficiently to allow the use of excavators to remove the softened dentine. Small cavities may not only be enlarged, but cleaned and formed, by the drills.

Some prefer excavators in the form of scoops, for the removal of the softened dentine, which should be completely removed, and a dense, normal surface reached, due regard being had to avoid injury to the pulp of the tooth. A knowledge of the anatomical structure of the teeth will enable the operator to avoid penetrating to dangerous points when excavating cavities. Burs operated by the dental engine can

be applied at almost any angle, and prove very serviceable in preparing cavities for fillings.

The part of the tooth surrounding the orifice should present no rough or brittle edges. The size of the bottom of the cavity should be as near that of the orifice as is possible, even a little larger, rather than any smaller. But the difference between the size of the one and the other should never be very great; for if the interior of the cavity is much larger than the orifice, it will be difficult to make the filling sufficiently firm and solid to render it absolutely impermeable to the fluids of the mouth.* If, on the other hand, the orifice is larger than the bottom of the cavity, it will be difficult to obtain sufficient stability for the filling, so as to prevent it from ultimately loosening and coming out. It often happens, however, that the situation and extent of the decay is such as to render it impossible to make the cavity so large at the bottom as at the orifice; when this is the case, several pits or circular grooves should be cut in the inner walls, for the purpose of obtaining as much security for the filling as possible; being careful to make these in the dentine rather than in the enamel, which is so much more brittle. By proper attention to this precaution, a filling may be so inserted in this difficult class of cases as to prevent it from coming out.

As a general rule it is easier to form a cavity in the grinding surface of a molar or bicuspid than in any other position; though it sometimes happens that even here it is attended with difficulty, and especially when the decay, commencing in the center, follows the several depressions which run out from it. In such cases the edges bordering on and covering the affected parts, which are often thick and very hard, should be cut away, together with the subjacent decayed dentine; the radiating depressions should open fully into the central cavity, and be made sufficiently wide and deep to admit of being filled to their extremities in the most perfect and substantial manner. The surface of a filling occupying a cavity of this kind presents a sort of stellated appearance. When two or more decayed places are separated only by very thin walls of tooth-substance, these should be cut away, and a cavity formed large enough to include all the diseased points; as one

* Place a lump of cotton in the hollow of the hand formed by bringing the ends of the fingers against the palm. Then press with an instrument upon the center of the cotton, and it will leave the sides of the cavity. This simple illustration, suggested by Dr. Edward Maynard, will explain the cause of failure, in certain cases which have come under his notice, from the hands of operators of deservedly high reputation. The cavity, smallest at the orifice, had been well filled; but the final compression upon the center had drawn the gold from the sides, thus permitting the access of fluids, and ultimately decaying the tooth around the filling.

large filling will secure the preservation of the tooth more effectually than by filling each cavity separately.

Sharp angles should be avoided, as far as possible, in the outline of the orifice of the cavity, because of the extreme difficulty of filling them compactly. The orifice must also have a firm, decided margin, with no thin projecting edges of enamel on the one hand; with no countersunk depressions on the other. In the first case the thin enamel is apt to break off either during the operation or subsequently; in the second case the thin scale on the edge of such fillings breaks away in the course of time; in both cases the filling fails perfectly to answer its purpose in the preservation of the tooth.

The enamel edges of every cavity, in preparing it for the introduction of a filling, should be smoothed by means of enamel chisels or the margin chisels, or the stone wheels and points, so that it may be somewhat countersunk. Too much care cannot be taken to properly prepare the enamel edges, as the perfection of the filling depends in a great measure upon the adaptation of the gold to such edges or margins.

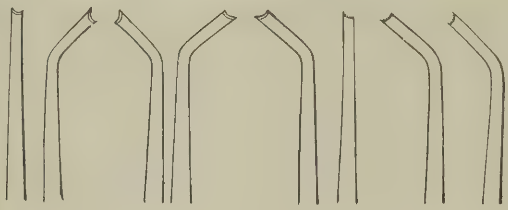
It is preferable, in many cases of front approximal fillings, to cut away the inner angles of the tooth, thus avoiding the injury to the external appearance of the tooth caused by the file, etc. Upon completion of the operation, the surface thus cut is perfectly polished, as every filled or cut surface upon the teeth should be, and so shaped as to be kept readily cleansed with the brush or with floss silk. It is also very important that all parts of the cavity should be accessible and free from moisture before the introduction of the filling.

All *débris* accumulating during the cutting away of softened dentine and the formation of the cavity should be removed, either by the syringe with tepid water, or blasts of air, the latter being preferable where it is desirable to keep the cavity dry during the entire excavation.

In forming a cavity for the reception of cohesive gold foil, it is very necessary that it should be of such a shape as to retain securely the first gold introduced, and to accomplish this one or more small cavities, called retaining points, can be made within the larger cavity. These retaining points in many cases afford anchorage for the entire mass of gold composing the filling, and in every case where cohesive forms of gold are used, they are the support in the building up from the bottom to the orifice of the cavity.

These retaining points are formed in the dentine by means of a small, square, chisel-edged spear, or spear-shaped drills, and can very often be made of one sixteenth of an inch in depth; a less depth, however, will answer in many cases. One of these retaining points in connection with one or two under-cuttings on the opposite wall

will be sufficient in some cavities, while in others two or three are



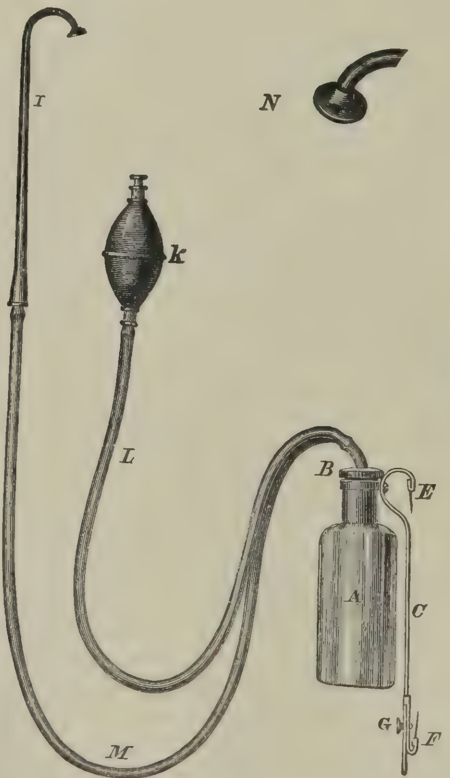


Fig. 405. Fig. 406. Fig. 407.

required. The gold should be introduced into these retaining points in such a manner as to form, when they are filled, solid masses of

metal, which would require considerable force to dislodge them. Upon these solid masses the gold filling the cavity is built.

Fig. 405 represents a set of Dr. E. S. Talbot's Margin Chisels and Pluggers, for cutting, rounding, and smoothing the edges of cavities, leaving them in a condition to receive the gold, which should be adapted accurately to the margins.

Protecting Cavities from Moisture.—The first step in this operation is to wipe the mucous membrane covering the parts about the tooth to be filled perfectly dry, as well as the mouth of the duct of the nearest salivary gland, from which saliva may flow in such a manner as to interfere with the operation of filling the cavity. Before the introduction of the rubber-dam the following method was pursued to protect cavities from moisture: Over the mouth of the duct a roll of bibulous paper was placed, upon which rested one part of a napkin, which was so arranged about the tooth as to prevent the mucous secretions from reaching the cavity. The napkin was held in place by the thumb and fingers of the left hand. The remaining portion of the napkin could be used to prevent the breath from coming in contact with the material used for filling, as well as the cavity. When this was accomplished, the cavity was dried, as hereafter described, and was then ready for the filling. Much more difficulty was met with in protecting cavities in the inferior teeth from moisture than in the case of the superior, and various appliances were devised to overcome it.

The common saliva pump (Fig. 407) is used to remove the saliva as it accumulates in the lower part of the mouth, and consists of a glass tube with an elastic bulb.

Fig. 406 represents a very superior saliva pump. *A*, bottle or reservoir. *C*, clamp, furnished at its upper and lower ends with two steel pins, *E*, *F*, to secure it to the upholstery of a chair, so that it cannot be detached by accidental force. When used, the hard-rubber mouth-tube, *I*, is held in the mouth by one hand of the patient, and the bulb, *K*, in the other. Whenever saliva accumulates, the patient presses the bulb, and the saliva flows into the reservoir. The reservoir is emptied by unscrewing the cap, *B*. A very ingenious improvement on this instrument has been recently made for attachment to the "fountain spittoon," the current of the water causing a constant automatic suction, by which the instrument is operated and the mouth kept free from saliva.

Fig. 408 represents the Adjustable Fountain Spittoon with the Saliva Pump attachment.

The Rubber Dam.—For one of the most simple, yet effective, appliances for controlling the flow of saliva and protecting cavities from

moisture we are indebted to the late Dr. S. C. Barnum. It consists of nothing more than a thin sheet of India-rubber, of good quality that it may possess sufficient strength and not

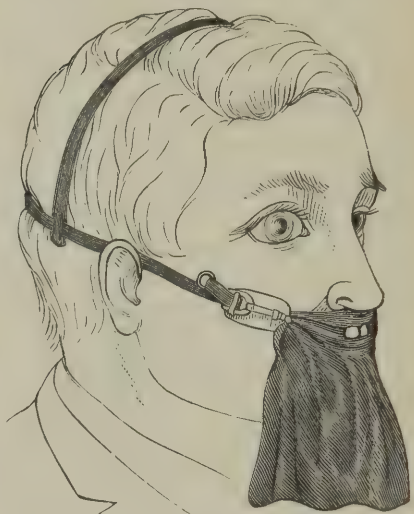


FIG. 409.

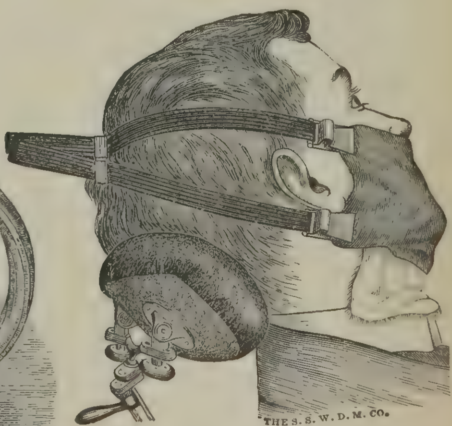


FIG. 410.

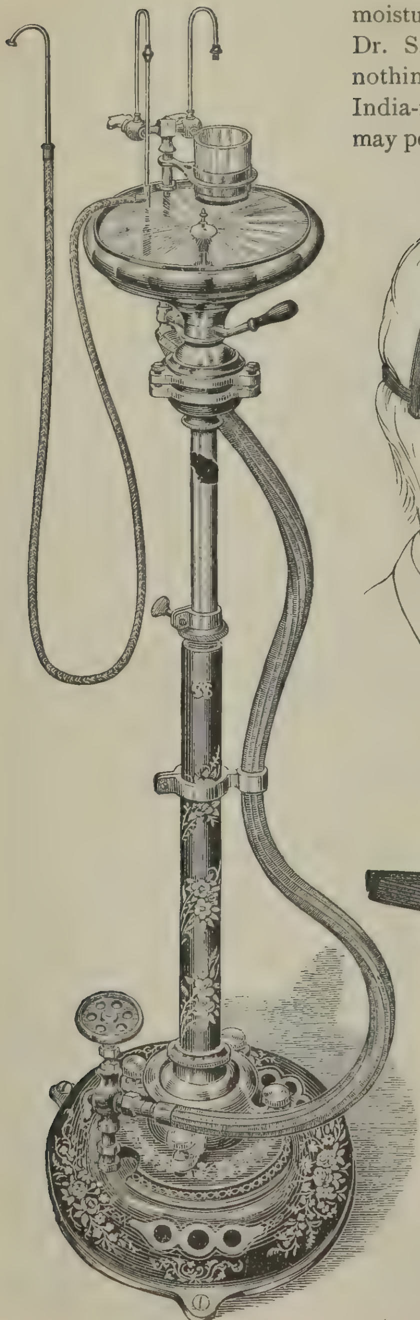


FIG. 408.

tear easily, and of a thickness double that of letter paper.

Some distance from the edge of the sheet, which is from four

to eight inches square, one, two, or more holes are made, through which the crowns of the teeth are passed when it is applied to the mouth.

The holes made in the rubber should be about one-tenth smaller in diameter than the necks of the teeth they are to embrace.

Fig. 409 represents the Rubber Dam in position, and Fig. 410 represents a "dam holder" in connection with the rubber dam.

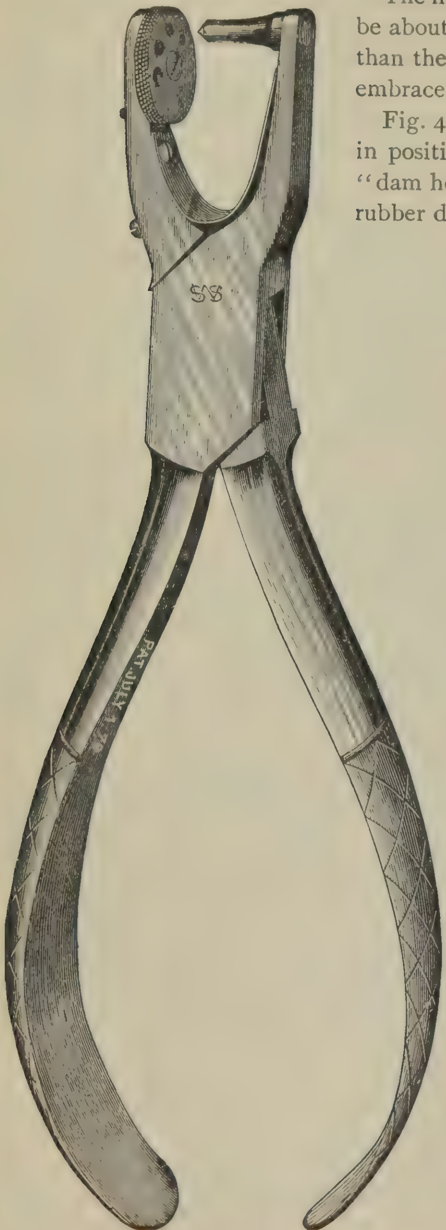


FIG. 411.

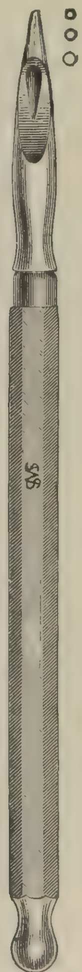


FIG. 412.

It is better in all cases to make several of these holes in the sheet, in order to include within the coffer-dam formed when the sheet is in position the crowns of the teeth adjoining the one in which the cavity to be filled is situated. When the crowns of the teeth approximate closely, the holes should be made about one-eighth of an inch apart; if some space exists between the crowns the holes may be made at a greater distance from each other. These holes may be formed in the rubber by means of a small chisel-edged punch, Fig. 412, or by the Ainsworth punch, Fig. 411.

The rubber, thus prepared, is carried between the teeth by either a thin, flat burnisher, or, which is better, by waxed floss silk, and the margins of the holes pressed gently under the free edges of the gums in the direction of the roots of the teeth.

These margins should be secured to the necks of the teeth by means of waxed floss silk tied around them, or by the use of suitable clamps, such as are now manufactured for that purpose.

Fig. 413 represents an "Applier" for the use of waxed floss silk in adjusting the Rubber Dam.

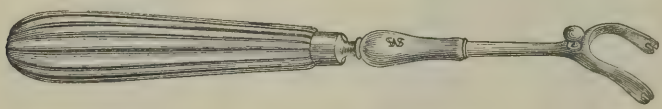


FIG. 413.

Fig. 414 represents some of the many forms of Rubber-Dam Clamps, used for securing the rubber dam to the necks of teeth. Forms of these clamps are made with tongue-guards.

Fig. 415 represents the Rubber-Dam Clamp Forceps, by means of which the clamp, in connection with the rubber dam, is placed in position on the tooth.

Figs. 416, 417, and 418 represent the How, Johnson, Climax, and Ivory cervix screw-clamps, and the T. A. Long clamp.

Several other simple appliances are in use to protect cavities from moisture, such as wooden wedges forced between the necks of the teeth, and waxed cord surrounding the tooth in which the cavity is situated, and passing to an adjoining tooth; also a band of rubber cut from tubing, which is placed high up on the neck of the tooth and then carried around an adjoining one. Two of these bands, acting in opposite directions, answer better than a single one, and in many cases effectually protect this cavity from moisture.

Drying Cavities.—After every particle of decomposed dentine has been removed, the cavity should be thoroughly cleansed before the filling is introduced. This may be done by first injecting tepid water

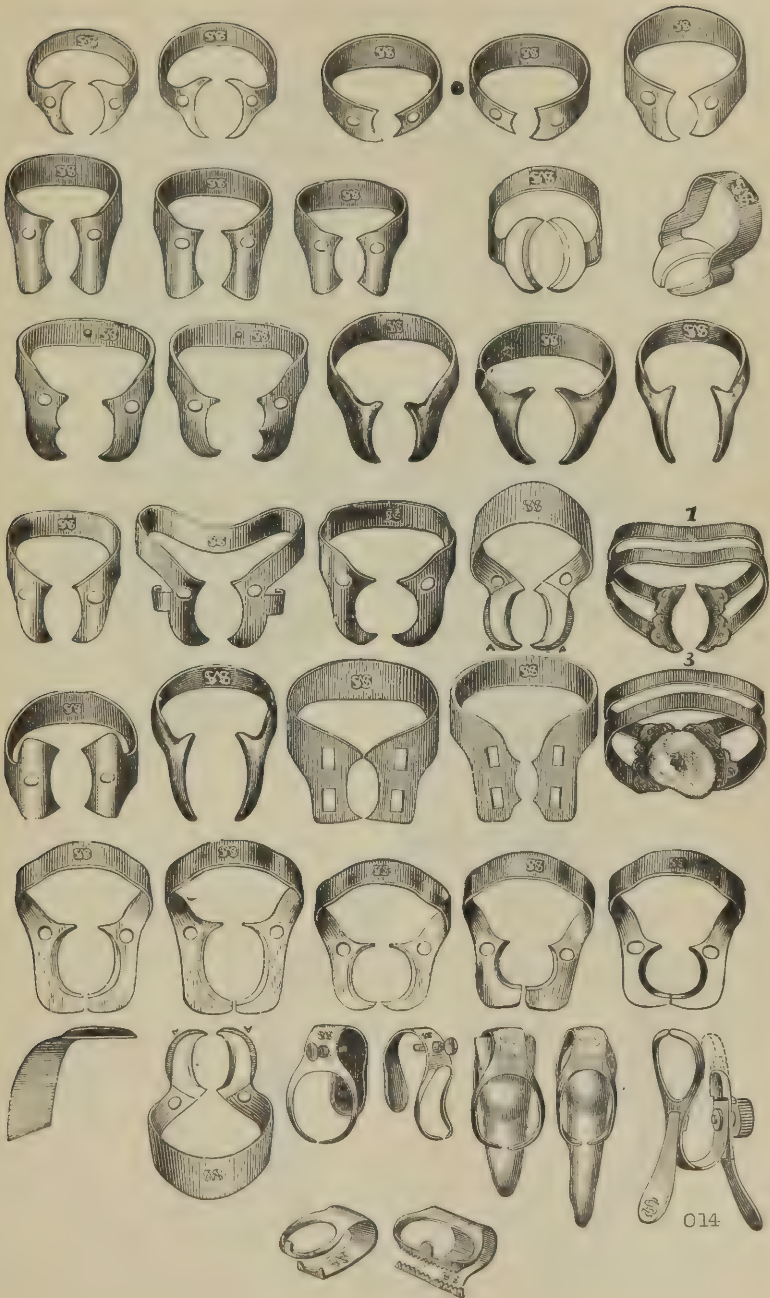


FIG. 414.

into it with a properly constructed syringe, and afterward wiping it dry with a small lock of absorbent cotton fixed upon the point of a

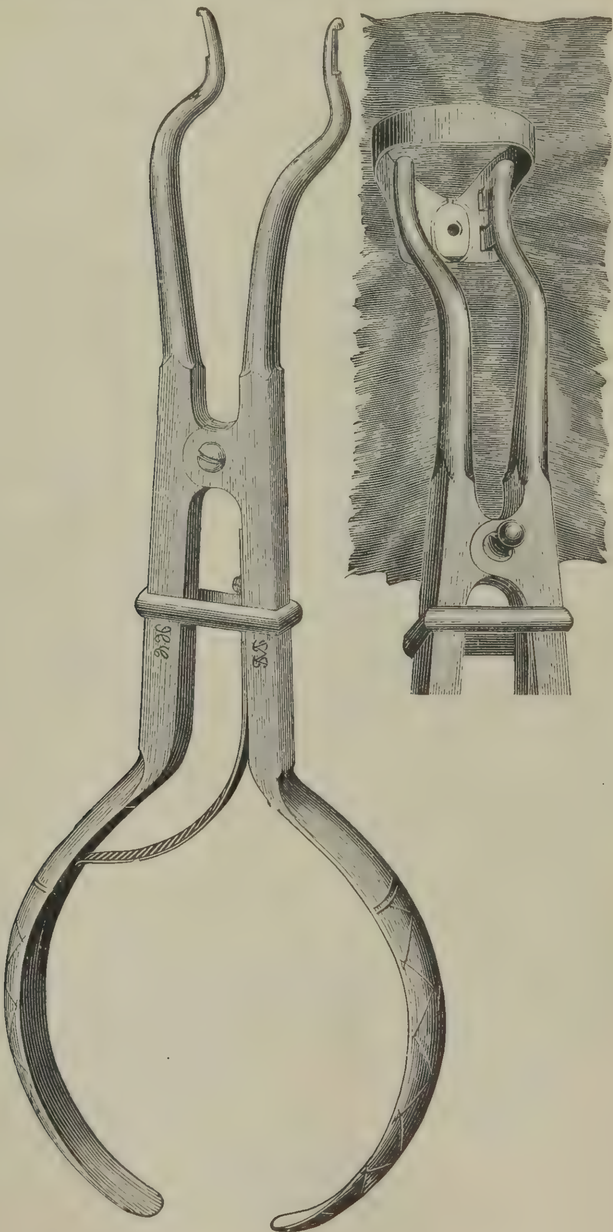


FIG. 415.

probe or excavator; or the cavity may, in the first place, be wiped with a little raw cotton moistened with water and afterward with absorbent cotton. The application of the cotton should be followed by that of Japanese bibulous paper, which has a very loose, absorbent texture, and may be folded, for convenience, in the form of a rope, from which the moistened end can be torn after each insertion. Tissue or bibulous paper absorbs moisture more perfectly than cotton. The absorbing qualities of cotton, however, may be increased by boiling it

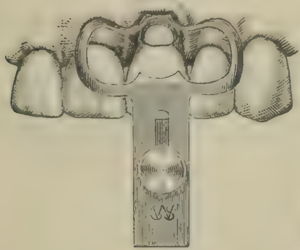


FIG. 416.

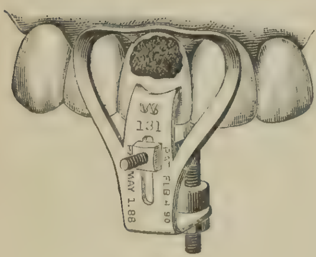


FIG. 417.

FIG. 419.

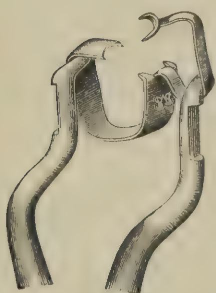


FIG. 418.

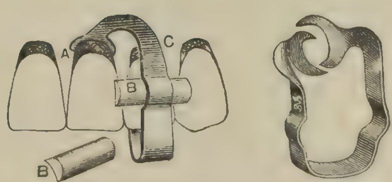


FIG. 420.

for fifteen or twenty minutes in a tolerably strong alkaline solution; this done, it should be thoroughly dried before using; or by saturating it with sulphuric ether to remove the natural oil. Several materials have been of late years used in drying cavities, such as prepared flax, fine and white, with a long, absorbent fibre, prepared spunk, absorbent

cotton. Fig. 421 represents a Hot-air Syringe for drying cavities, the heating chamber being filled with carbon, the best known retainer of heat. To fill this syringe with heated air, the turret of the air-chamber is held in the flame of a spirit-lamp; the turret, being pro-

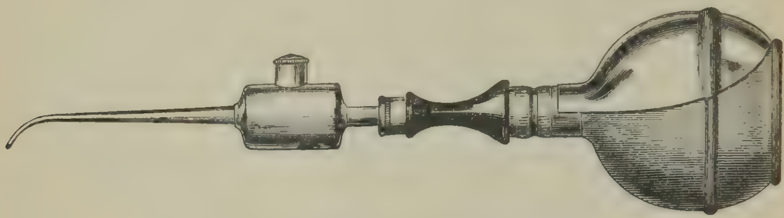


FIG. 421.

vided with a metallic valve, recedes as the bulb, after being compressed, fills with air and allows the flame to be drawn into the chamber. It is desirable that the cavity should be perfectly dry before the filling is introduced.

INSTRUMENTS FOR INTRODUCING AND CONSOLIDATING GOLD.

For introducing and consolidating non-cohesive gold foil, a number of instruments are required, which should be sufficiently strong to resist any amount of pressure the dentist can safely exert in the operation. Hand instruments should have round or octagonal handles, large enough to prevent the liability of being broken and to enable him to grasp them firmly. Their points should vary in size, though none should be very large. Several should be straight, but for the most part they require to be curved—some very slightly, others forming with the shaft of the instrument an angle of 90°. Fig 422 represents a set of small-pointed hand pluggers. For other forms the reader is referred to the chapter on "Filling Individual Cavities."

Plugging instruments, as received from the instrument makers, have usually a temper which will not permit them to be bent. It will add, we think, greatly to the value of the instrument if the practice of Dr. Maynard were more generally adopted. He gives to the extreme point a hard temper (straw color) to prevent it from wearing; for a little distance, say one to three-quarters of an inch, a spring temper is given (purple or blue color) to insure strength when the shape is delicate; the rest of the instrument is left soft, so as to admit of being bent (with pliers) in the direction best suited for that particular point in any given operation.

Most of them should have a slim wedge shape; some, however, both of the straight and curved instruments, should have blunt serrated

points, and a few should have highly polished oval points, for finishing the surface of fillings. Formerly, most dentists employed, for introducing and consolidating the gold, simple blunt-pointed pluggers; but it is impossible with such instruments to make a filling as firm and solid as it should be for the perfect preservation of a tooth, especially if the cavity is large. From one-fourth to one-half more gold can be

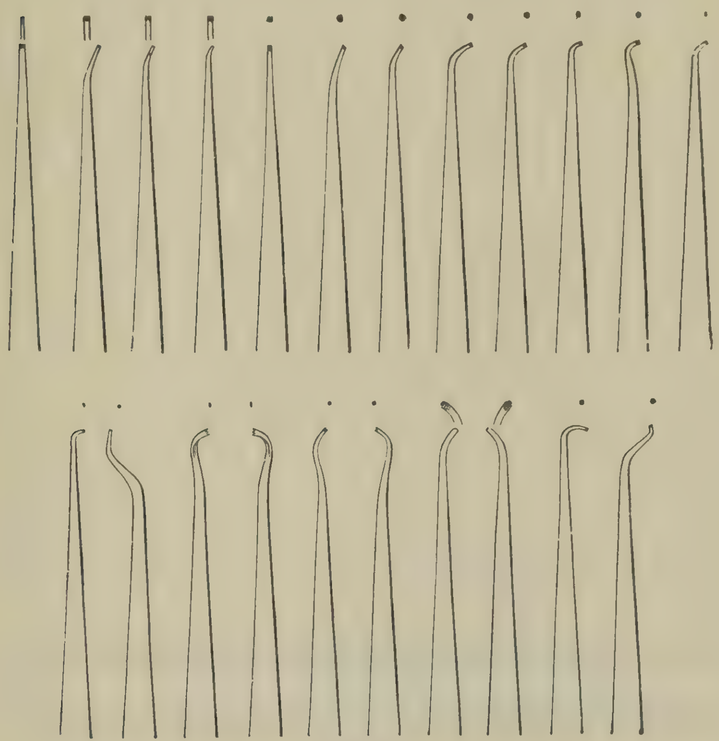


FIG. 422.

introduced into a tolerably large cavity with a wedge-pointed than with a blunt-pointed instrument.

Fig. 423 represents an excellent set of points designed by Professor James H. Harris for use in solid or socket handles, and also with the automatic or hand mallet, and although intended for cohesive gold, can also be used for the non-cohesive.

This general description will serve to convey a tolerably correct idea of the kind of instruments required for the operation.

Instruments having serrated points are required for filling teeth with crystal or sponge gold and with cohesive gold foil.

Fig. 424 represents some knurled handles for cone socket plugger points.

Fig. 425 represents Dr. R. W. Varney's set of Pluggers for the cohesive form of gold foil.

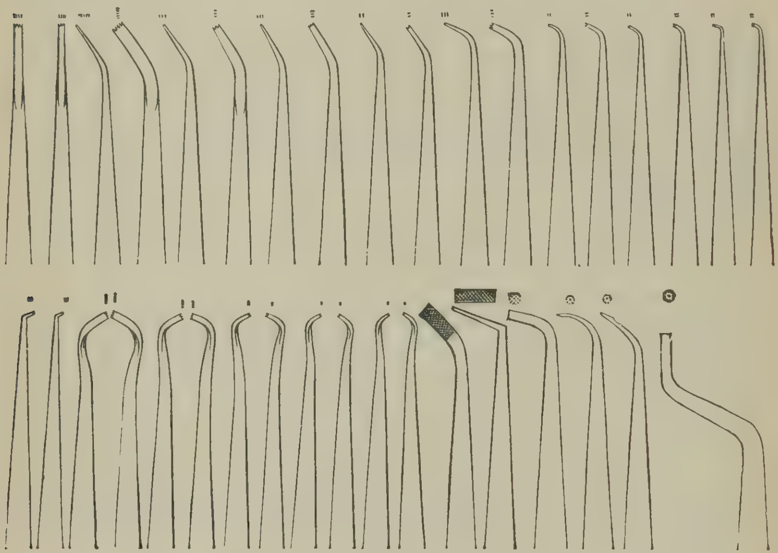


FIG. 423.

Fig. 426 represents Dr. Marshall H. Webb's set of pluggers, also for the cohesive form of gold foil.

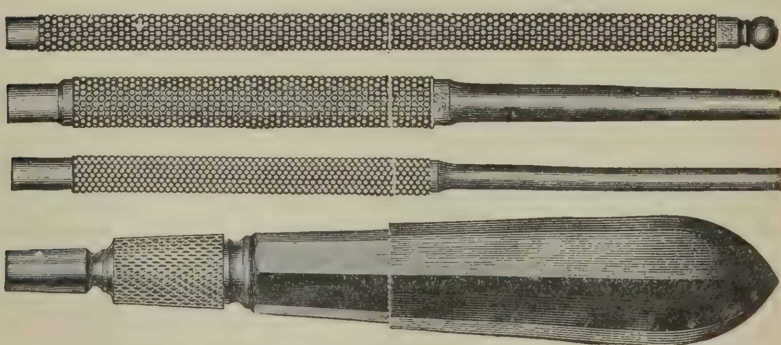


FIG. 424.

Fig. 427 represents Dr. Chapelle's malleting shaft pluggers, for the use of cohesive gold, especially No. 30 rolled cohesive gold, cut in strips $\frac{1}{16}$, $\frac{1}{8}$, $\frac{3}{16}$ inch wide and one inch long.

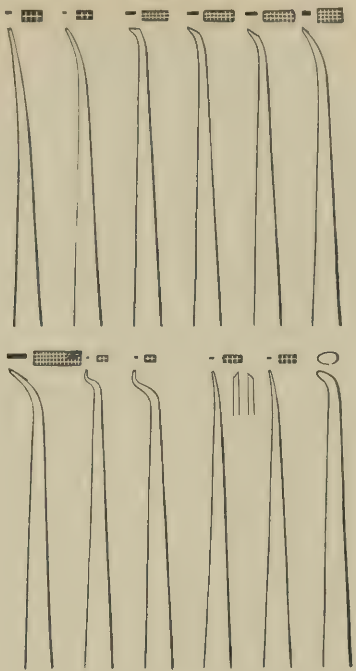


FIG. 425.

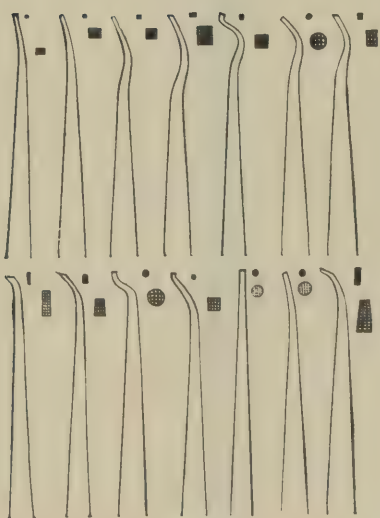


FIG. 426.

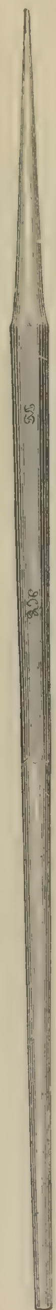


FIG. 427.

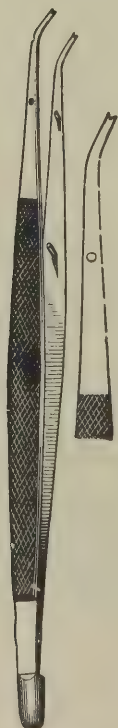


FIG. 428.

FIG. 429.

Fig. 428 represents a combined foil carrier and plugger, for taking up pieces of gold and placing them in the cavity and partially condensing them.

MANNER OF PREPARING, INTRODUCING, AND CONSOLIDATING GOLD, AND FINISHING THE SURFACE OF THE FILLING.

Non-Cohesive Gold Foil.—The operator, being provided with the necessary instruments, should cut this form of gold with a pair of foil-scissors into strips containing from one-fourth of a sheet to one whole sheet. Each of these should be loosely rolled or folded together lengthwise, by the aid of a foil-holder or spatula (Fig. 429), on a piece of soft spunk, covered with chamois skin or white kid—the foil-scissors and spatula have recently been combined into one instrument—and after the cavity has been properly cleansed and dried, the end of one fold should be introduced and carried to the bottom of the cavity, with a straight or curved wedge-pointed instrument; the roll on the outside should then be folded on the part first inserted. The folding should be commenced on one side of the cavity, and the inner end of each fold taken to the bottom, the outer extending nearly a twelfth or an eighth of an inch on the outside of the orifice; thus, fold after fold is introduced, until no more can, in this manner, be forced into the cavity. Having proceeded thus far in the operation, the instrument should be forced through the center of the filling and the gold firmly pressed against the walls of the cavity. The opening thus made should be filled in the manner as first described, and this time it should be packed in as tightly as possible. This done, the operator should endeavor to force a small, wedge-pointed instrument in the center of the filling, until he has tried every part of the plug, filling, as he proceeds, every opening which he makes, and exerting, in the packing of the gold, all the pressure which he can apply without endangering the tooth. If one roll or fold of gold is not enough, he should take another and another, until the cavity is thoroughly filled. When the walls of the cavity are frail it is the practice of some operators to introduce the gold rather loosely, and to depend upon surface condensing to obtain the necessary solidity. But it is better to well condense every fold immediately after it is carried to its proper place in the cavity; such condensing will often render the use of the wedge-shaped instrument unnecessary.

The advantage to be derived from introducing the gold in this manner is obvious. By extending the folds from the orifice to the bottom of the cavity the liability of the gold to crumble and come out is effectually prevented, and by introducing it with a wedge-pointed instrument it may be carried into all the depressions of the walls of the

cavity, and rendered altogether more solid than it could otherwise be made. The cohesiveness of the gold may be increased by slightly warming in the flame of a spirit lamp, after it has been made into rolls or folds.

After the cavity has been completely filled, every portion of the projecting part of the gold must be thoroughly consolidated before it is allowed to become wet, with a small, blunt-pointed instrument, straight or curved, as may be most convenient; or, if the filling is in the approximal side of a tooth, it may be compressed with the angle of the point of the plugger, making the adjoining organ, to a slight extent, a kind of fulcrum for the instrument. After the filling has been thus consolidated as long as it can be made to yield in the least to the pressure of the instrument, the protruding parts may be scraped or filed off, down to the tooth, so as to form a smooth, uniform, gently swelling, or perfectly flat surface. Fig. 444 represents a number of finishing files. If in this part of the operation any portion of the gold should crumble or be dislodged, which it will not do if it has been properly introduced and consolidated, the injury may be repaired by making, in the part of the plug where it has occurred, an opening, and filling it, or by the removal of the whole of the filling and the introduction of another. If any portions of gold have been forced over the edge of the orifice of the cavity they should be carefully removed, either with a file or sharp-pointed cutting instrument suited to the purpose. This precaution should never be neglected, especially when the filling is in the approximal surface of a tooth, where a portion of the gold is very liable to be forced up or down upon the neck and under the gum. If the filling is located on a masticating surface, a flat and level gold surface will answer the best purpose in preserving the tooth-structure; if upon an approximal surface, the filling should be contour, as a general rule. Soft or non-cohesive gold foil, in the form of the ribbon or loosely-rolled cylinders, is frequently used in connection with cohesive gold foil as a base upon which to build the latter form of gold. This combination is especially applicable in the case of cavities upon the approximal surfaces of the teeth and which extend to the gum. The soft or non-cohesive gold in such cases is employed to cover over the cervical walls, being first introduced into one of the angles of the cavity, until this wall is completely covered, when mallet force is employed to condense the mass which has been introduced, with a fine foot-plugger. On this base of non-cohesive gold, pieces or pellets or the ribbon of cohesive gold are condensed, and the filling completed with the latter form of gold. The non-cohesive gold, owing to its quality of adaptability, is capable of being closely packed against the most vulnerable walls of cavities,

where it may, in some cases, answer a better purpose in the preservation of the teeth than the cohesive forms would do in the same location.

Cylinder Filling.—The method of filling cavities with non-cohesive gold foil in the form of cylinders is a favorite one with many operators, and is in some cases, especially grinding surface cavities with firm walls, preferable to that of the fold or rope. A common method of preparing these cylinders is to fold lengthwise, in the form of a ribbon, either the third, half, or whole of a leaf of No. 4 or 6 gold foil; the width of the ribbon determines the length of the cylinders.

FIG. 430.

One end of this ribbon is then held between the thumb and index finger of the left hand, and wound upon a three- or four-sided broach until the cylinder thus formed is of the size desired, when the remaining portion of the ribbon is torn off.

The cylinders should be a little longer than the cavity is deep in order to allow for surface condensing. The density of the cylinders depends upon the tightness with which the ribbon is wound upon the broach; by winding it loosely upon the broach soft cylinders are formed, to be placed in contact with the walls of the cavity, while the hard cylinders made by tighter winding are introduced inside of the soft and form the center of the filling. Different forms as well as sizes

FIG. 431.

of cylinders are necessary in every case, cone-shaped as well as the true cylindrical. The cone-shaped cylinders are useful where there is an under-cutting, and also for completing the introduction of the gold.

These cone-shaped cylinders are formed by winding the ribbon back from the point of the broach, which should taper slightly, in order that the cylinder when completed may be easily detached.

Loosely rolled cylinders, prepared ready for use, can be obtained of manufacturers (Fig. 430).

These loose cylinders are useful, applied to the cervical walls of approximal cavities, as a base upon which to build cohesive gold foil.

Also the blocks or mats represented in Fig. 431.

For placing the cylinders in their proper places in the cavity the introducing pliers are necessary, which have smooth points bent at

such an angle as will permit of their being used when closed as a condensing point. See Fig. 428.

The cavity being prepared for the gold and properly protected from moisture, one of the soft cylinders is carried into it with the pliers and placed in such a position that one end rests on the bottom and the other protrudes from the orifice. Pressure in the direction of the wall against which the cylinder rests is then made with the closed points of the pliers, and afterward with a condensing instrument having either a smooth, wedge-shaped point, or, with what is better, a serrated point. When the first cylinder introduced has been well condensed against one of the walls of the cavity, others are introduced and condensed in succession, until these walls are covered by the soft cylinders. The hard cylinders are then disposed round the cavity in the same manner as the soft ones, until it diminishes so much as to render it necessary to form a cavity in the center of the gold already introduced, by means of a smooth, wedge-shaped instrument, such as is represented in Fig. 432. The cavity formed by this instrument is then filled with a small, dense

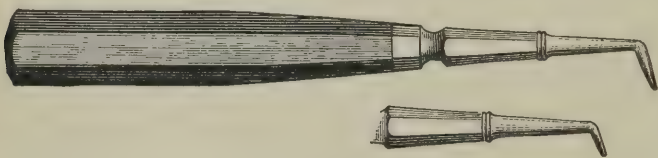


FIG. 432.

cylinder, and successive openings are thus made and filled until no more gold can be introduced, when the protruding ends of the cylinders are condensed by pressure applied in the direction of the bottom of the cavity. The surface of the filling is then finished in the manner to be described hereafter. To obtain an extremely dense surface, crystal or sponge gold may be added to the surface of a cylinder filling, before such a surface is condensed, by introducing it into the interstices between the cylinders projecting above the margin of the cavity and then applying mallet force.

When the cavity is of considerable depth and small in diameter, or the bottom is uneven, pellets of gold may be introduced and condensed upon the bottom until the cavity is about one-third filled. By this method the gold is better adapted to the bottom of the cavity than by placing the ends of the cylinders upon an uneven surface. The surface-condensing of cylinder fillings should be made with small-pointed condensing instruments, and any opening it is possible to make with them be filled with small, dense cylinders.

The Herbst Method.—Dr. Herbst, of Germany, has recently intro-

duced a method of manipulating a quality of soft or non-cohesive gold, in the form of cylinders, made by Wollrab, of Bremen, to which the name "rotation gold filling" has been given.

Fig. 433 represents the instruments used in the Herbst method, which are smooth, but not polished, and some of the points are quite fine. As these instruments, when made of steel, become coated with gold by its adhesion, they can be cleansed during their use by rubbing their points on a piece of block-tin or upon fine crocus-cloth; it has also been suggested to plate the points with gold. This German gold appears to become cohesive by rubbing it with the instruments, which have points like burnishers and are rotated in the introduction and consolidation of the gold. By slightly annealing the cylinders they can be united, and even hammered, without crumbling in pieces. The cavities into which this form of gold is introduced are prepared in the usual manner, with their edges smooth and slightly rounded off; deep retaining points are unnecessary, and but few pits are required.

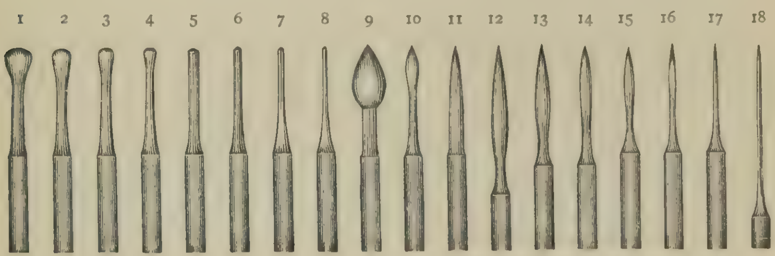


FIG. 433.

For filling an ordinary cavity in a grinding surface, the quantity of gold first introduced should be large enough to be retained when condensed, without support from an instrument, which is accomplished by packing the cavity loosely, but quite full of the cylinders, when the instruments numbered 2, 3, or 4 (Fig. 433), by a slow rotation, burnish the gold against the walls. A second layer of gold is made to adhere to the surface of the first gold introduced, by the use of the form of instrument represented by numbers 5, 6, 7, or 8, by rotating it quickly until the polished surface of the first gold introduced has been destroyed, when the second layer of gold will adhere to it. The filling of the cavity is continued in this manner until all of the gold necessary is introduced and consolidated.

For filling two superior incisor cavities in opposite approximal surfaces, after being prepared in the usual manner, they are treated as one cavity by introducing the gold into both at the same time (bringing over), first securing it in the four corners or angles by rotation with

the instruments represented by numbers 5, 6, 7, 8, according to the size required, so that a common mass of gold appears. The fine-pointed instrument, No. 18, is then inserted, with regular rotation, into this mass, between the two teeth, until it is separated, when thin files or discs and tape are employed to finish the surfaces of each filling.

For filling two similar cavities in the approximal surfaces of bicuspids and molars a matrix is used, which is secured in place between the teeth with shellac, one cavity being first filled by commencing the introduction of the gold against the cervical wall or border, and condensing against the matrix at that point, and then toward the center of the crown. The first cavity being filled, the shellac is removed and the remaining cavity filled in the same manner. The rotation and pressure of the instruments appear to produce sufficient heat to render the gold cohesive, and it is claimed that a filling by this method and with this quantity of gold can be inserted very quickly, and that it is impermeable to all fluids.

Pellets.—Another form in which non-cohesive gold foil is used is that of pellets, which are formed by lightly rolling a portion of a sheet between the thumb and fingers. They are made of different sizes, and when placed in a cavity are welded together by means of pointed or serrated instruments. It is necessary that the first pellets introduced should be securely anchored, in order that the successive ones may be built upon them ; these last should be small enough to allow the welding instrument to pass through them to the gold beneath.

COHESIVE GOLD FOIL.

Cohesive gold foil is well adapted for all shallow cavities and for restoring lost portions of the crowns of teeth. While non-cohesive gold is retained by the general form of the cavity, cohesive gold is anchored by means of retaining points or pits, on the principle of welding one piece or fold to another until the required quantity is introduced. The number of retaining pits will depend upon the form of cavity to be filled, varying from three to six. The depth of these retaining points will also depend upon the strength of the walls of the cavity, as will also, in a great measure, their diameter; as a general rule, a greater number of small pits if the wall is weak, and a few large pits where the wall is strong, or where a portion of the filling has to withstand great force. These retaining pits are made with small, square-edged drills, to a depth corresponding with the diameter of the drill, and in a direction opposite to each other, and in a line with the force to be resisted. Each of these retaining pits is solidly filled with pellets of a suitable size, the pieces of gold being conveyed to the cavity

by means of the introducing pliers, and thoroughly condensed by mallet force. The retaining pits being filled, the gold is built over from one to the other, until the surface upon which they are located is covered, which secures a base for the entire filling. Larger pellets are then built upon this base, care being taken to adapt the gold perfectly to the walls of the cavity by gradually building it somewhat higher against the walls than in the center. The operation is continued in this manner until the edge of the cavity is reached, when the gold is built up in the center and above and over the margins, to permit of its being so cut away as to conform to the original contour of the surface which it is to restore.

The cutting away of the surplus gold is accomplished by means of suitable plug-finishing files, or plug-finishing burs, corundum disks or points, Hindostan or Arkansas stone points, etc., after which smoothing process a high polish is given to the entire surface.

In manipulating with cohesive foil, a preliminary step in the operation is to attend to the quality of the gold. It must possess sufficient cohesiveness to cohere under moderate pressure; and as this property deteriorates on the exposure of the foil to the atmosphere, it is often necessary to restore it by the application of heat, as the welding principle, and not mechanical force, is relied upon. To accomplish this, the gold, either in the sheet, ribbon, or pellet form, is subjected to the flame of an alcohol lamp until it becomes a bright red.

Fig. 396 represents a gold-foil annealing lamp. A wire-gauze frame is very convenient for re-annealing the entire sheet, and a mica plate or platinum pan for the pieces or pellets. Many prefer to pass the roll and pellets directly through the flame at the moment they are being carried to the cavity with the introducing pliers. Another method is to boil the gold for a few minutes in a solution composed of forty drops of sulphuric acid and two gills of rain-water. This diluted acid removes all extraneous matter from the surface of the gold, which soon dries, and is found to be very cohesive.

There are a number of methods by which this form of gold foil is prepared for introduction into the cavity. One consists in tearing fragments from a sheet, previously annealed, and condensing a single thickness at a time with a fine serrated point. Another method consists in lightly rolling up the whole or part of a sheet in the form of a rope and cutting this up into pellets of different sizes. In forming the pellets, the sheet should be very lightly rolled up between the thumb and fingers, or, what is better, lightly folded by means of a foil folder, and chamois skin. It may also be folded within the leaves of

the book containing it, into two, three, four, or more ribbons, according to the size of the cavity to be filled, and then cut with the scissors.

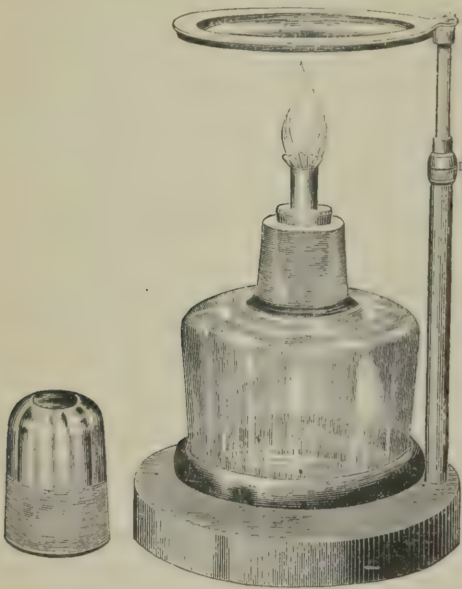
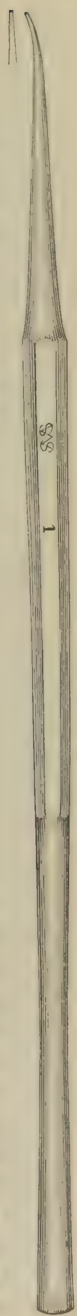


FIG. 434.

Some, instead of forming pellets, prefer to introduce this quality of gold in a long rope, or, better still, a ribbon containing from one-tenth to one-half sheet of No. 4 foil, which is annealed by holding it in the center with the pliers and rapidly passing it through the flame. When the gold is ready to introduce and the cavity is carefully dried and protected against moisture—absolute dryness being very essential in the use of all the cohesive forms of gold—the first pellet, or the end of the rope or ribbon, when such forms are used, is carried from the flame to a retaining point in the cavity, where it is securely anchored by being thoroughly consolidated by means of instruments having fine serrated points. As soon as the retaining points are solidly filled, the gold is built up from these over the bottom and sides of the cavity, care being taken to condense it well against the walls as it approaches the orifice. Every pellet or fold must be consolidated as it is introduced, and the gold built up higher against the *walls* of the cavity than in the center, until the orifice is reached, when the depression left in the center can be filled up. Very lightly rolled or folded gold should be applied to the walls of the cavity, else it may clog, and cannot be consolidated to such a degree as is necessary to give solidity to the filling. It is beyond question that to the introduction of the rubber dam is due the splendid achievements with cohesive gold of the present time, as it is absolutely necessary that such gold, during its manipulation, should be kept perfectly dry. The rubber dam has, therefore, become an indispensable aid in all manipulations with gold as a filling material. Should moisture interfere with the introduction of gold in filling a tooth, it is far preferable to re-



move all that has been introduced and commence anew than to depend upon any attempt to dry the surface by means of heated air from the hot-air syringe.

Figs. 423, 425, 426 and 427 (pages 486, 487 and 488) represent the forms of instruments for introducing and consolidating cohesive gold foil.

Heavy Foil.—A number of years ago attention was directed by Dr. Robert Arthur to the use of the heavy numbers of gold foil for filling teeth; and later the interest in this form of gold revived to such a degree that very many advocated its claims.

Nos. 15, 20, 30, 60, 120, and even higher numbers have been used. Nos. 15 and 20 can be consolidated by hand force, if such is desired, while the heavier numbers require mallet force. The method of manipulating this foil is to cut

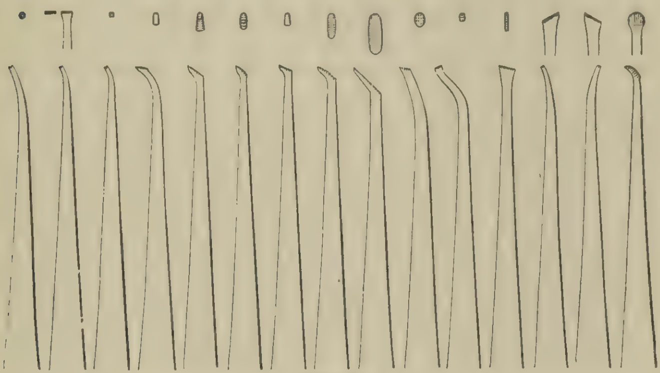


FIG. 435.

it—without allowing it to come in contact with the fingers—into pieces varying from one-fourth to three-fourths of an inch square, or into strips of a proper width and length to suit the cavity to be filled. The gold is then annealed by heating each piece or strip, held by the pliers in the flame of an alcohol lamp, to a red heat. For filling the front teeth the strip is preferable, condensing each layer across the entire surface of the cavity and folding the strip upon itself. Retaining points are solidly filled and the gold built from one to the other, presenting as uniform a surface as possible, and not allowing the foil to become crumpled or folded irregularly upon itself. For filling the posterior teeth the small pieces are preferable, introduced, like the strip, with the pliers, and each one thoroughly consolidated. The gold should be

carefully condensed at and over the margins of the cavity, layer by layer.

The manufacture of these heavy foils by rolling instead of beating is said to render them softer and more cohesive; but, in the editor's opinion, this form of gold offers no advantages over the lighter numbers, such as No. 4. On the contrary, it is decidedly more difficult of manipulation and far less easily adapted to the walls of the cavity. Some have found it useful for finishing out the surfaces of large fillings.

Fig. 435 represents a set of Dr. C. R. Butler's instruments for manipulating the heavy foils with mallet force.

CRYSTAL OR SPONGE GOLD.

In the use of crystal or sponge gold a different method of procedure is required from that employed with foil.

The chief difference between the instruments employed for introducing and consolidating crystal gold in the cavity of a tooth and

FIG. 436.

those used for gold foil, consists mainly in having the working extremity blunt, varying in diameter from a line to almost a mere point, with shallow serrations upon the surface.

Fig. 436 represents a set of instruments well adapted for the manipulation of crystal gold.

In filling teeth with crystal gold the cavity is prepared in the same manner as when leaf gold is employed. This done, the gold is cut, or rather torn, from the block with the point of an instrument, into small pieces, varying in size according to the dimensions of the cavity and the particular stage of the operation in which it is to be used. It being important that the crystals or particles composing the mass should be as little separated or displaced as possible before the piece is carried to its place in the tooth, this form of gold should be used in pellets as large as can be introduced into the cavity with-

out crumbling. The gold being divided into pieces of the proper size, the cavity is washed, and then wiped dry with prepared cotton, or flax and bibulous paper ; a piece of gold, as large as the orifice of the cavity will receive, is taken up with suitable pliers or one of the sharp-pointed instruments, as may be most convenient.

The spongy mass readily adheres to the serrated surface of the working extremity when pressed gently upon it, and with this it may, in most cases, be carried to the bottom of the cavity. Every part must now be thoroughly consolidated, first with a large, and next with a smaller, and lastly with a very delicately-pointed instrument, so bent that it may be readily applied to all the depressions and inequalities of the walls and floor of the cavity ; for unless the fold is made absolutely solid in these places, as well as throughout all the parts of the filling, the success of the operation will be more or less uncertain. Thus, piece after piece is applied, consolidating each one as the operation progresses, until the gold protrudes sufficiently from the orifice of the cavity to admit of a good finish, leaving the surface flush with that of the tooth.

If, during any part of the operation, the smaller-pointed instruments can be forced between the gold and the walls of the cavity, such opening or openings should be filled with smaller masses of the material before another large piece is introduced. This precaution ought never to be neglected ; for should any soft places exist after the completion of the operation, the filling will be apt to absorb moisture, and ultimately to crumble and come out. It is also indispensably necessary that the gold, during its introduction into the tooth, be kept absolutely free from moisture, as this destroys the cohesive or welding property of the crystals.

The gold having been introduced and consolidated as directed, the exposed surface is scraped or filed down to a level with the orifice of the cavity, then made smooth by rubbing it with Arkansas stone or with finely-powdered pumice, and burnished or polished with crocus, in the manner as described when gold foil is used.

In finishing a filling made with these preparations of gold the operator should see that there are no thin, overlapping portions upon the teeth outside of the orifice of the cavity. They are liable, in biting hard substances or in ordinary mastication, to be broken off, leaving a depression for the lodgment of extraneous matter and clammy secretions. Sooner or later this will give rise to a softening of the dentine thus exposed, which, if it does not cause the filling to loosen, will ultimately render its removal and replacement necessary. In short, the precautions necessary to be observed in making a filling with gold foil are equally necessary when the

operation is made with either of the preparations now under consideration.

Mallet Force in Consolidating Gold.—A number of years ago Dr. W. H. Atkinson introduced a method of consolidating gold by means of mallet force, which has now become a favorite one with many of the best operators in the profession. He claimed for this method the following advantages over hand pressure: A more perfect condensation of the gold and a more thorough welding than can be made by hand pressure; that the gold will be anchored in its position with much more facility; that the instrument always acts under the mallet upon the designed point, does not slip from its position, and, consequently, there is no liability of abrading or wounding the soft parts; that mallet force is not more unpleasant to the patient than the ordinary method of condensing, and that it is far less fatiguing than hand pressure in protracted operations.

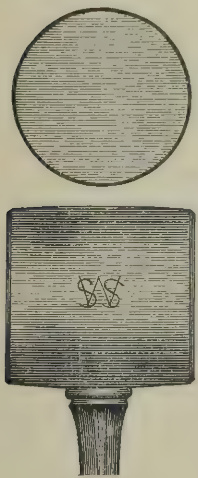


FIG. 437.

That mallet force is an effective method of condensing the cohesive forms of gold there can be no question.

Mallets of almost every description have been used, such as wood, lead, tin, copper, brass, steel, ivory, and vulcanized rubber.

The steel mallet, however, is considered by many to produce the best results, while the lead mallet gives a dead blow and may be more agreeable to the patient.

Heavy lead and tin mallets, weighing from four and a half to six and a half and even eight ounces, are preferred by many of the advocates of the hand mallet.

In using the hand mallet, which is represented in Fig. 437, the aid of an assistant is necessary, who taps the end of the plugger squarely with sharp, springing strokes, while the principal operator directs its condensing point over the gold as it is introduced into the cavity.

With instruments called automatic mallet pluggers—Figs. 438 and 439 represent Snow and Lewis's, Fig. 440 Abbott's—the aid of an assistant is unnecessary.

All of these forms operate by the action of a spiral spring, and some of them have a back action.

Automatic pluggers for use with the dental engine are also employed for the condensation of gold in filling teeth.

Fig. 441 represents an engine mallet invented by Dr. W. G. A. Bonwill, having his hand-piece attached. This engine mallet gives a very

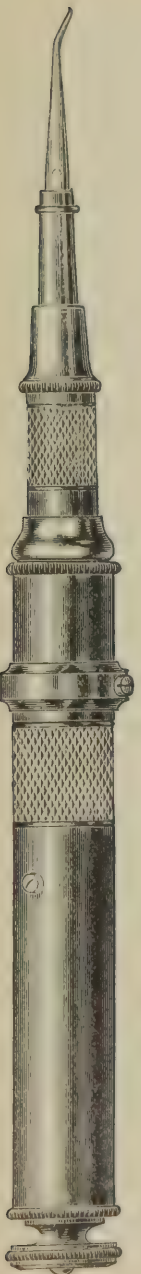


FIG. 438.

FIG. 439.—Double Action.

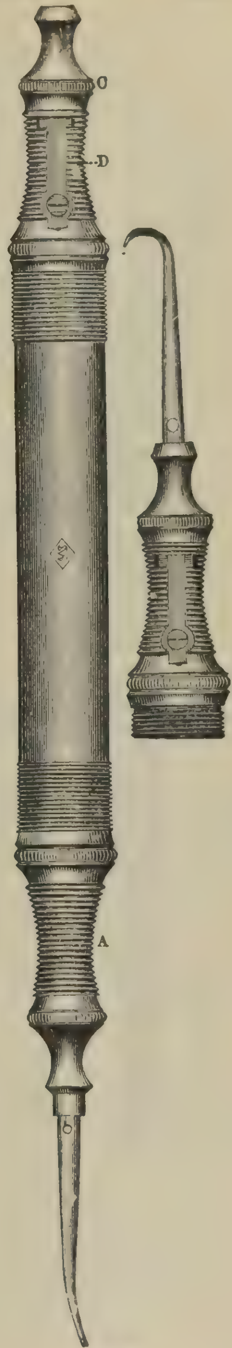


FIG. 440.

satisfactory blow, and requires but little foot power, and can be worked by either foot and on either side of the chair.

Fig. 442 represents the electro-magnetic mallet invented by Dr. W. G. A. Bonwill, which is used by many of the most skillful operators. The blow is delivered upon the packing instrument, just at the point where its force is greatest, as the attraction of the magnets constantly increases as the mallet approaches them until the circuit is broken. By combining the stem and holder of the Electric Mallet with the striking mechanism of the Mechanical Mallet No. 1, an appliance is formed in which the operator can use effectively the long-handle pluggers made for the electric mallet. Ordinary socket-points can also be used in it with equal facility by means of the proper socket-handles.

FIG. 441.

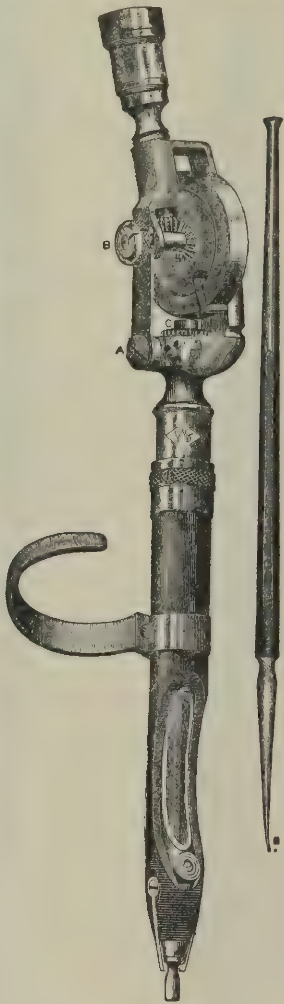


FIG. 442.

Fig. 443 represents a set of instruments devised by the late Dr. Marshall H. Webb, for use with the electro-magnetic mallet.

Finishing the Surface of the Filling.—After having thoroughly consolidated the surface of the filling, finishing files, such as are represented in Fig. 444, are used to remove the protruding portions of gold and to form a smooth, uniform surface, free from the slightest indentations which may afford lodgment to extraneous matter. This is a point never to be lost sight of; for, however excellent the filling may be in

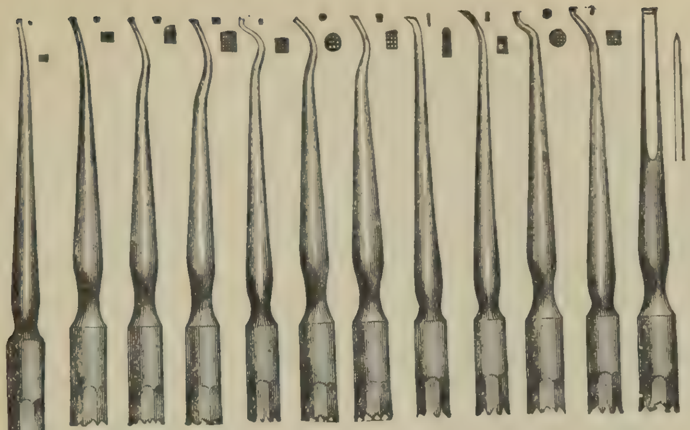


Fig. 443.

Fig. 444.


Fig. 445.

other respects, if the surface is not smooth, uniform, and flush with the orifice of the cavity, the object intended to be accomplished by it will be partially, if not wholly, defeated.

It is better, however, to cut off but a portion of the protruding gold at first, and then to burnish, condense, and to cut a second time, with a fine file or bur or an emery strip, all it is necessary to remove. After each filing, and before applying the burnisher, the surface should be cleansed of all loose pieces of gold. After a second burnishing, the Arkansas, Hindostan, or Scotch stone, or finely-powdered pumice, may be applied to the surface, to remove all the file scratches and other asperities. For a filling in the approximal surface of a tooth the stone may be shaped like a pinion file; it should be frequently dipped in water, and when its pores become filled with gold the surface may be ground off by rubbing it on a corundum slab. If the filling is finished with pumice, it may be applied with floss silk or tape moistened with water, by drawing it backward and forward across the surface of the filling.

Fig. 445 represents plug-finishing files, for finishing contour compound gold operations in the approximal surfaces of teeth. With them the gold can be so finished as to restore the natural contour, thereby preventing the surfaces of the teeth from assuming an unnatural contact.

Fig. 446 represents different forms of plug-finishing burs for use with the dental engine.

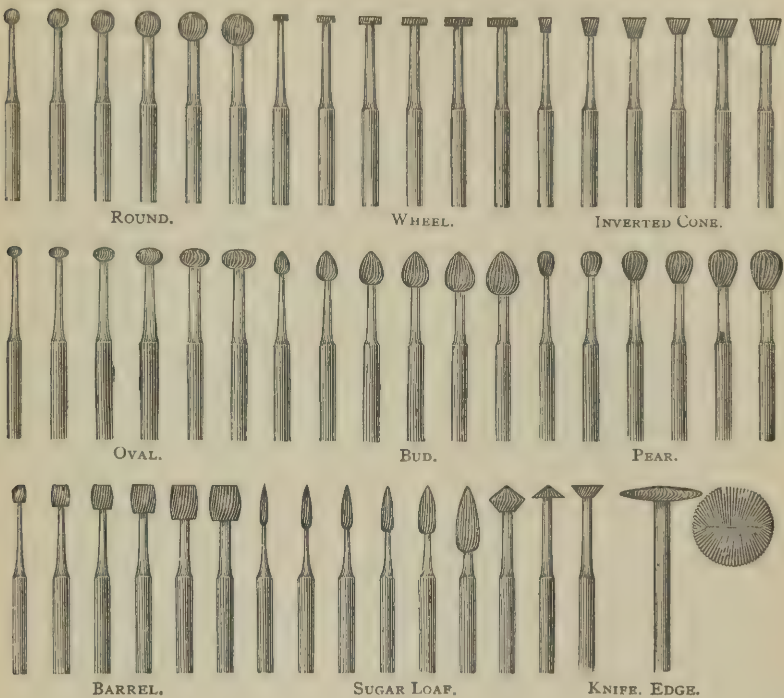


FIG. 446.

Fig. 447 represents an excellent file-carrier, contrived by Dr. Forbes, for files for finishing fillings on the approximal surfaces of the front teeth, and Fig. 448 a tape-carrier.

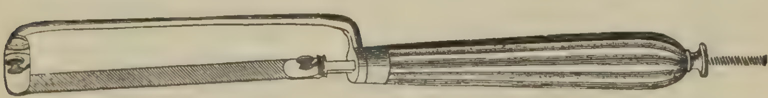


FIG. 447.

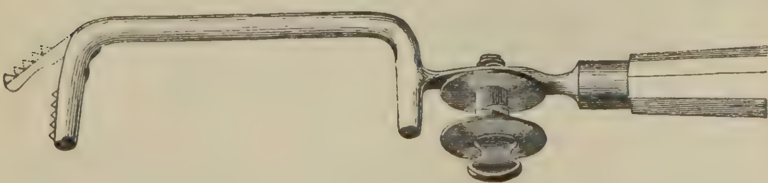


FIG. 448.

Fig. 449 represents a small split tape arbor for carrying a short piece of polishing tape (Fig. 449 *a*), which by the turning of the bit in the hand-piece is rolled on to the arbor and becomes a small polishing-point that will reach fissures and depressions between cusps to finish fillings or gold contour work in a quick and superior manner. Fig. 449 *b* shows the small size of the polishing point thus obtained, but by rolling on a longer piece of tape a correspondingly larger point will be made. Sand-paper discs are also useful.

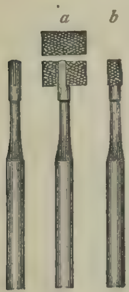


FIG. 449.

If the filling is in the grinding, buccal, or palatine surface of a molar or bicuspid, a long piece of stone, having a small, triangular, and slightly oval point, may be used; if powdered pumice-stone be employed, it may be used on the point of a similarly-shaped piece of soft wood, previously softened in water. After all the asperities have been cut down, the surface should be washed until every particle of grit is removed.


FIG. 450.

This done, it may be polished with a suitable burnisher, dipped from time to time in a solution of pure Castile soap, until the filling is rendered as brilliant as a mirror. Fig. 450 represents various forms of burnishers.

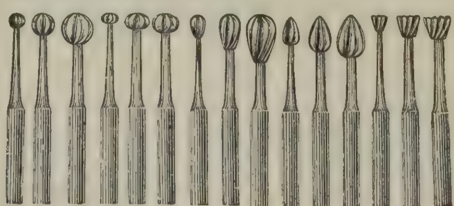


FIG. 451.

Fig. 451 represents a set of burnishers for use with the dental engine. Also, Dr. Brown's metal tape, used with wet polishing-pow-

der, will be found very effective, especially in spaces too small for the entrance of silk (Fig. 452).

Various instruments are used in the process of finishing the surface of metallic fillings, such as coarse and fine burs, corundum points, wood points, emery strips, sand-paper discs, all rotated by the dental engine.

Fig. 453 represents finishing strips with crimped finger-holds, for proximate surface-fillings.

Fig. 454 represents Dr. J. W. Smith's mandrels for carrying paper, felt, or rubber discs.

Having proceeded thus far, the surface may be again washed and the operation completed by rubbing it from three to six minutes with dry floss silk. Rouge or rotten stone applied to the surface on tape, or finely-powdered

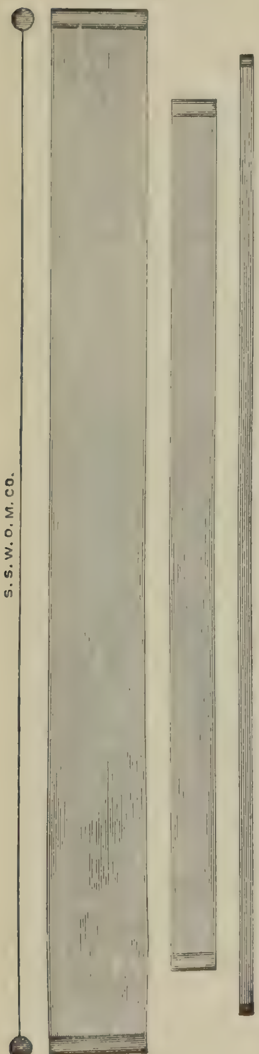


FIG. 452.

FIG. 453.

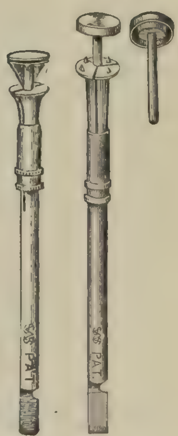


FIG. 454.

silex or pumice-stone on a piece of orange-wood after it is prepared by the method just described, will remove the bright metallic lustre—when this is objectionable on account of the exposure of the filling—

and leave a fine finish. Holly strips in the form of thin shavings answer admirably for applying levigated pumice, rouge, etc., in the polishing process.

Non-Conductors.—When the caries has penetrated nearly to the pulp cavity, the presence of a gold or any other metallic filling is sometimes productive of considerable pain and irritation, especially when hot or cold fluids are taken into the mouth or during the inspiration of cold air. In some cases inflammation and suppuration of the pulp supervene. To prevent these disagreeable results a variety of means have been proposed. Dr. Solyman Brown recommended placing asbestos, this being a non-conductor of caloric, on the bottom of the cavity previously to the introduction of the gold. The author prefers chloro-percha, which may be used in the form of a thick solution, or a layer of thin gutta-percha may be placed at once in the bottom of the cavity. When the solution is used a drop may be placed in the cavity, and a sufficient time allowed for the chloroform to evaporate before introducing the filling. A thin layer of "Hill's stopping," of which gutta-percha forms the principal ingredient, may be used with equal advantage. Oxychlorids and oxyphosphates of zinc have also been used for the same purpose, but the latter are less irritating than the former, and neither possesses any advantages over gutta-percha.

The time required by an expert operator to fill a tooth well may be said to vary from thirty minutes to two hours and a half, or even longer, according to the size, shape, and situation of the cavity, and in some cases a much longer time will be required. Less time and skill are usually required to fill a cavity in the grinding than in the approximal surface of a tooth; but the operation in either place, to be beneficial to the patient, must be performed in the most thorough manner. The dentist who does not feel the importance of making all his operations as perfect as possible should never be intrusted with the management of these important organs. Want of attention to two points in the consolidation of a filling often causes the ultimate failure of operations in all other respects well performed. First, by not making sufficient *lateral* compression whilst introducing the gold the surface is apt to be more solid than the interior. Consequently the filling may drop out for want of a firm contact against the sides; or, if retained, it is apt on grinding surfaces to be pressed inward, leaving a space around the orifice for the penetration of fluids. Second, want of care in condensing around the edges of the filling will, by the crumbling away or scaling off of portions of the gold, expose the edges of the cavity to decay.

In every part of the operation the dentist should so guard his instru-

ments as to prevent them from slipping, which he will usually be better able to do by standing a little to the right and behind his patient than in any other position. In filling the lower teeth he should stand several inches higher than while filling the upper, and for this purpose he should have a stool or movable platform on which to stand. When it can be done, he should grasp the tooth with the thumb and forefinger of his left hand, not only to prevent it from being moved by the pressure he applies, but also to catch the point of the instrument in case it should slip; if he is always careful to press in a direction toward the orifice of the cavity this need not happen; nevertheless, he should always take the precaution to guard against possible accident. When he cannot shield the mouth with the thumb and finger of his left hand, he should let the thumb or one of the fingers of his right rest either upon the tooth he is operating on or upon some other.

For the special application and modification of these general directions the reader is referred to the filling of individual cavities in teeth.

FILLING INDIVIDUAL CAVITIES IN TEETH.

To describe the method of filling each individual cavity in every locality in which a tooth is liable to be attacked by caries would be unnecessarily tedious. But as this is one of the most important and, at the same time, one of the most difficult operations in dental surgery, it may be well to enter a little more into detail upon the subject than we have as yet done. In doing this the writer will confine himself, for the most part, to the manner of filling a cavity in each of the following localities, which are the parts of teeth most liable to caries.

First. In the approximal and labial surfaces of the superior incisors, and cuspids and the palatine surfaces of the incisors, the anterior surfaces of the cuspids and the posterior surfaces of cuspids and incisors being rarely attacked by caries.

Second. In the grinding, approximal, buccal, and palatine surfaces of the molars and bicuspids of the upper jaw.

Third. In the approximal surfaces of the inferior incisors and cuspids.

Fourth. In the grinding, approximal, and buccal surfaces of the molars and bicuspids of the lower jaw.

Other parts of the teeth sometimes become the seat of caries, but the foregoing are the localities most liable to be attacked by the disease.

FILLING THE SUPERIOR INCISORS AND CUSPIDS.

I. *With Non-cohesive Gold Foil.*—In describing the manner of introducing a filling in one of the first-named teeth, we shall commence with the right approximal surface of the left central incisor.

The directions we propose giving for the performance of the operation here will be applicable, with a few exceptions, to the same surface on all the upper incisors. As a general rule, the gold should be introduced from behind the teeth forward and upward, and for the following reasons: 1. When the aperture between the teeth has been formed with a cutting instrument it should, when circumstances of the case will permit, and for reasons stated in another place, be made wider behind than before; consequently the diseased part can be most easily approached from this direction. 2. The gold, in the majority of cases, can be more conveniently introduced from the palatine side, and the force required for condensing it can be more advantageously applied.

The exceptions to the above rule are when the approximal side of the tooth is turned slightly forward toward the lip, and when the caries is situated nearer the labial than the palatine angle; also, when the teeth, instead of occupying a vertical position in the alveolar border, or projecting slightly, as they usually do, incline backward toward the roof of the mouth. It sometimes happens, too, when they are separated by pressure, that the diseased part can be most conveniently reached from the front surface.

The instrument which the author has found best adapted for the introduction of the gold into a cavity in the right approximal surface of

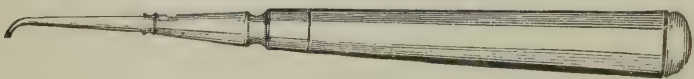


FIG. 455.

an incisor or cuspid tooth is represented in Fig. 455. The width and length, as well as the curvature or angle of the point, should vary according to the size of the cavity and the width of the space between the teeth.

The stem of the instrument, as well as the shank, should be strong enough to sustain any amount of pressure which it may be necessary to apply in forcing the folds of gold tightly against each other. The point should be wedge shape and the extremity serrated.

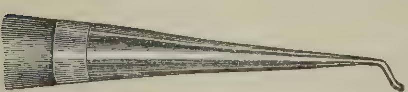


FIG. 456.

The decay having been removed, the cavity, properly shaped, cleansed, dried, and protected, is ready for the reception of the gold. The patient should be seated in a chair sufficiently high to bring the head on a level with the breast of the operator and resting on the head-piece of the chair, with the face upward. The operator, standing upon the right side, should support the patient's head firmly with his

left arm during the operation, while with the forefinger of the same hand the upper lip is held out of the way. The middle finger of the same hand ought to rest on the end of a tooth to the left of the one on which the operation is being performed, while with the little finger the lower lip may be gently depressed. The roll or strip of gold is first introduced with the foil pliers.

During the introduction of the gold the instrument should be held in the right hand of the operator (Fig. 457), and grasped with sufficient firmness to prevent it from slipping or rotating.

In introducing the gold the first fold should be applied against the upper wall of the cavity, that the pressure may always be exerted in a direction toward the extremity of the root, applying each additional fold as closely to the preceding one as possible. The folds should also, in their introduction, be applied as closely to the labial and palatine walls of the cavity as possible, but always directing the pressure, when these are thin and brittle, in the direction of the axis of the root.

FIG. 457.

When the lower part of the cavity is very narrow, as is often the case, especially where it extends nearly to the labial angle of the tooth, it is often necessary to change the instrument for one having a smaller point.

To carry a fold of gold to the bottom of a cavity upon the point of the instrument, without breaking or cutting it, requires some tact. The point should never be carried directly toward the bottom; on entering the orifice, it should be inclined toward the wall of the cavity opposite the one against which the folds are first laid. Equally as much tact is required to prevent displacing the gold before a sufficient quantity has been introduced to procure support for it from the surrounding walls, which is an accident particularly apt to occur with young practitioners, when the cavity is superficial and has a large orifice. To prevent this, the folds of gold should be long enough to project some distance from the orifice, that they may receive support from the adjoining tooth, and from the thumb and forefinger of the left hand of the operator, until the operation has reached that stage when sufficient stability shall have been obtained from the walls of the cavity.

There are cases in which an instrument like the one represented

in Fig. 458 can be very advantageously employed in the introduction of the gold; but in the majority of cases the instrument represented in Fig. 455 will be found more convenient.

After having filled the cavity so thoroughly that a small wedge-pointed instrument cannot be made to penetrate the gold at any point, the extruding portion of the filling should be consolidated, beginning with the portions overlapping the lower part of the tooth and the edge of the posterior wall. These should be carefully and firmly pressed toward the cavity with an instrument having a flat point, like the one represented in Fig. 459. This done, it may be firmly applied to every part of the surface of the filling, continuing

FIG. 458.

FIG. 459.

the pressure as long as the point of the instrument can be made to indent the gold.

When the space between the teeth is very narrow, an instrument shaped as in Fig. 460 may be used. The operator should be provided with two or three instruments like each of the two last, varying in the size, length, and curvature of their points.

During the process of consolidating the gold, the tooth should be firmly grasped between the thumb and forefinger of the left hand; this prevents it from being pressed too forcibly against the opposite side of the socket, while, at the same time, the end of the forefinger, by being placed above the instrument, assists in directing its point

FIG. 460.

FIG. 461.

and serves to keep it from slipping. When the labial and palatine walls of the cavity are very thin, great care is necessary to prevent fracturing them in introducing and consolidating the gold. The consolidation should be commenced around the edges, and the pressure applied toward the centre of the cavity.

It sometimes happens that the caries extends forward to the labial angle of the tooth, and upward, at the same time, under the edge of the gum. Great difficulty is often felt in thoroughly filling this portion of the cavity, and it cannot always be done from behind the tooth. In this case, after having filled the cavity in the manner as already described, the operator may, standing on the left side of the patient, and with an instrument having a wedge-shaped point (Fig.

461), make as large an opening as possible in the gold. This done, he may grasp the left lateral incisor or cuspid tooth with the thumb and middle finger of his left hand, elevating the upper lip with the forefinger of the same; then, with the instrument held as in Fig. 462, he may proceed to introduce the gold, filling the upper part of the opening first. After introducing fold after fold, until the cavity is completely and compactly filled, the extruding portion should be consolidated with a similarly-shaped instrument, having a flat, serrated point, this style of point being preferable to the round point for introducing and consolidating non-cohesive gold.

The size of the roll of gold must be varied to suit the size of the cavity, though it should seldom have in it more than a fourth of a leaf of No. 4. If more than this is employed at one time, it will be difficult to apply the folds sufficiently near each other.

The method of filling the right central incisor in the left approximal

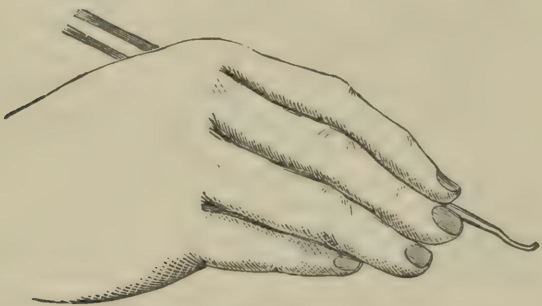


FIG. 462.

surface is so very similar to that of filling the left in the right side that it will not be necessary to enter so minutely into detail. In this, as in the other case, the gold, as a general rule, should be introduced from behind the tooth, forward and upward; but if introduced from the front, the operator should still stand on the right side of the patient. The head should have the same elevation and inclination backward but the face should be turned more toward the operator, to give him a better view of the cavity in the tooth, and to enable him to reach it more readily with the instrument.

The cavity being formed, cleansed, and dried, the operator may proceed to introduce the gold as already directed, with an instrument like the one represented in Fig. 455. In many cases, however, he will require one having a somewhat longer point, and curved at nearly a right angle with the stem. The instrument should be held somewhat differently in the hand (Fig. 463), and grasped firmly with the thumb and fore and middle finger, so as to prevent it from rotating.

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The head should be securely confined with the left arm, the upper lip raised with the left thumb, pressing it at the same time firmly against the anterior surface of the tooth. The middle or forefinger of the same hand may be placed against the gum just inside the tooth, to direct the application of the point of the instrument, prevent the liability of its slipping, and control the free end of the roll of foil. The lower lip may be depressed either with the middle joint of this or with one of the other fingers.

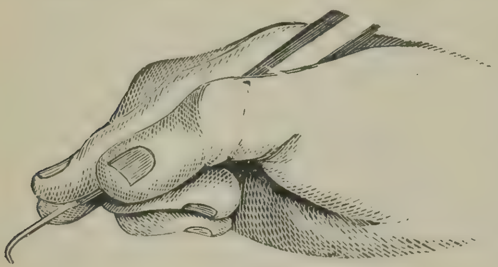


FIG. 463.

After having placed one end of the fold in the cavity, fold after fold should be introduced until it is compactly filled, except in those cases where the lower part is very small, when a smaller-pointed instrument should be employed for the completion of the operation and, indeed, for the introduction of all the gold, if the cavity is not large, or the aperture between the teeth very narrow.

For consolidating the extruding gold, the instrument represented in Fig. 459 will, in many cases, be all that is required. But the one represented in Fig. 464 can sometimes be used very advantageously;

FIG. 464.

FIG. 465.

and the one in Fig. 465 will be found a useful condenser for the right as well as the left approximal surface of an incisor or cuspid tooth; and both the last mentioned instruments may often be used to great advantage on the approximal surfaces of other teeth. Some of the instruments employed in filling teeth with cohesive and crystal or sponge gold may also be advantageously employed in consolidating the ordinary gold in the approximal surfaces of the incisors and other teeth.

In completing the operation, it is important that every particle of gold overlapping the orifice, and frequently extending under the free edge of the gum, should be removed before finishing the surface of the filling; but the operator ought, at the same time, to avoid as much as possible wounding the gum and peridental membrane. As the cavity frequently extends a little above the gum, great care is necessary to

prevent wounding it; indeed, there are many cases in which it cannot be avoided, unless the point of the gum is pressed up between the teeth by the introduction of a piece of raw cotton, band of rubber or wedge of wood, or Hill's stopping, a day or two before the operation of filling is performed.

In filling an incisor or cuspid tooth on the labial surface the operation is often very simple and easy, but there are many cases in which it is both difficult and tedious. The head of the patient should rest with the face upward, as already described, and sustained in the same way, with the left arm of the operator, while, with the thumb of the left hand placed on the gum above the tooth, the upper lip should be elevated.

The forefinger should be pressed firmly against the palatine surface of the tooth and the left side of the chin gently grasped with the other three fingers. Then, with an instrument (Fig. 466) having a wedge-shaped point, grasped with the right hand, as in Fig. 463 or 467, the operator should proceed to introduce the gold, standing at the right side of the patient, with the thumb of the right hand resting on a tooth to the left of the one he is about to fill or against the cheek. He should commence by laying the first fold against the walls of the cavity nearest to him, and thus introduce fold after fold, until it is compactly filled. The extruding portion may be consolidated with a round or square-pointed instrument, or with a sharp-pointed one, as represented in Fig. 468. Great care is necessary to prevent the instrumeut from slipping and wounding the gums. After having partially consolidated the gold, the overlapping portion must be firmly pressed toward the centre of the cavity, and the point of the instrument repeatedly applied to every part of the surface of the filling, until it can no longer be made to yield to pressure. This done, the gold may be filed down to the level of the tooth, smoothed with Arkansas stone, and burnished or polished.

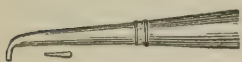


FIG. 466.

FIG. 467.

When the cavity is shallow and the orifice broad, the gold, as it is introduced, must be held in its place with the thumb of the left hand

until a sufficient quantity has been placed in the cavity to obtain for it the necessary support from the surrounding walls. But in overcoming difficulties of this sort, the peculiar circumstances of the case can alone suggest the proper means to be employed by the operator.

The decay sometimes extends entirely across the labial surface of the tooth, leaving after its removal a horizontal groove open at both ends. In this case the walls should be made rough, wider at the bottom than at the opening, and the operation of filling commenced at one end by applying the folds of foil alternately against the upper and lower wall, and consolidating them so thoroughly as to prevent the liability of their being displaced during any subsequent part of the operation. Successive folds are introduced in the same manner, each in close contact with the preceding series, until the groove is completely filled, applying the pressure, during the whole of the operation, against the two walls. In condensing the extruding gold, the operator should commence first at one end of the groove, then at the other, and afterward consolidate the whole surface of the filling. In finishing the operation, the same precaution with regard to wounding the

FIG. 468.

FIG. 469.

FIG. 470.

gum and peridental membrane should be observed here as recommended for the approximal surface of the tooth.

Although it rarely happens that the palatine surfaces of the upper incisors are attacked by caries, yet the disease does sometimes develop itself there, in the indentations occasionally found a little below the free edge of the gum. The removal of the diseased part, the formation of a cavity, and the introduction of a filling can, in the majority of cases, be more easily accomplished in this than in any other part of an incisor tooth.

The cavity being properly prepared for filling, the head should be placed as before directed, except that the chin may be a little more elevated, to enable the operator to obtain a more convenient view of the locality of his operation: the thumb of the left hand may be placed on the labial surface of the tooth and the forefinger on the gum immediately above the palatine surface. He should now, with a wedge-pointed instrument, shaped as in Fig. 469, proceed to introduce the gold, applying the first fold against the palatine wall or the palato-approximal angle of the cavity, as may be most convenient. Having filled the cavity, the extruding gold may be condensed with an instrument like the one represented in Fig. 470.

Sometimes straight instruments, and at other times instruments curved at the points more than those represented in Figs. 469 and 470, can be more conveniently employed, depending altogether upon the size of the mouth and the forward or backward deviation of the teeth from a vertical position. This is a matter, therefore, which the judgment of the operator must determine.

II. *With Cohesive Gold Foil.*—For filling cavities in the approximal surfaces of the superior incisors and cuspidati, the most effectual means should be adopted to retain the filling. In some few cases it may not be possible to do more than form small undercuttings at each approximal angle of the cavity, and another similar one at the cutting-edge, which would be sufficient for the retention of a non-cohesive gold filling; but in the majority of cases one of cohesive gold can be so securely anchored that the cervical wall is perfectly protected, and a fracture at any point along the edges of the cavity will not dislodge the filling.

To effect this, retaining-points, made by a small, square-edged drill, are necessary, which can be formed in approximal surface cavities of the incisors and cuspidati, in that portion of the dentine near the labial surface where it unites with the cementum, and in the same position in the palatine surface. These retaining-points can be made from the one-twentieth to the one-sixteenth of an inch in depth, and in addition a small undercutting on the wall next to the cutting-edge. In drilling the retaining-points in the cervical wall near the labial and palatine surfaces, the drill should be directed in a line with the long axis of the root, in order that the cavity made by it is sufficiently distant from the pulp of the tooth. The cavity being properly formed, dried, and protected from all moisture, the gold foil, prepared in the manner before described, is carried into the cavity with the introducing pliers or on the point of an instrument, and packed into the retaining-points until these are solidly filled.

The gold is then compactly built from one of these retaining-points to the other, and over the floor of the cavity, until a base is formed extending over the whole of the floor.

From this base the gold is then built to the orifice; and during the entire process it is packed a little higher about the walls than in the centre, in order to obtain a more thorough contact. When the gold has reached the orifice, the centre is then built up and the surface condensed and finished as before described.

Crystal gold is preferred by some for filling the retaining points and forming the base covering the floor of the cavity, on account of its retaining its position better than foil. This description of the method of introducing cohesive foil will apply to all cavities wherever situated,

and need not be repeated hereafter. For crystal gold the cavity may be formed in the same manner as for cohesive gold foil, although many depend upon under-cuttings instead of retaining points for its retention.

The margin of the cavity to be filled should be uniformly shaped, to permit of the easy introduction of the gold over them when it is carried into the cavity, and the edges should be slightly countersunk, to protect them from fractures and to permit of a more perfect adaptation of the gold to the margins, and also to properly define the margins of the filling in the process of finishing the surface. Such directions will apply to all cavities in teeth during their preparation fcr filling.

FILLING THE SUPERIOR MOLARS AND BICUSPIDS.

I. *With Non-cohesive Gold Foil.*—In describing the manner of filling a cavity in each of the principal localities liable to be attacked by caries in the above-mentioned teeth, the writer will begin with the grinding surface of the first molar on the right side. The directions given for filling a cavity here will, with a few exceptions, be applicable to the introduction of a filling in the grinding surface of any of the upper molars or bicuspids.

When the cavity is very deep and its circumference not large, it is difficult, if not impossible, to make a filling sufficiently firm and solid in every part by the introduction of folds of gold long enough to extend from the bottom to the orifice. The operation, therefore, should be divided into two parts; two-thirds of the cavity should be first thoroughly filled with vertical folds, and afterward the remaining third in the same manner.

In filling a molar or bicuspid on any part of its surfaces the head of the patient should, for the most part, occupy very nearly the same position and have the same elevation as required for an operation on an incisor or cuspid. The cavity being prepared for the filling, and one end of the roll or ribbon of foil placed in it, the tooth may be grasped with the thumb and forefinger of the left hand of the operator—the former placed on the buccal surface in such a manner as to press back the commissure of the lips, and the latter on the palatine surface; then fold after fold may be introduced and forcibly pressed against the posterior wall until the cavity is filled. For this purpose an instrument may be used like the one represented in Figs. 466 or 469. If the former is used, it is to be held as shown in Fig. 463. The extruding portion should then be condensed with the same instrument as the one used for introducing, and still more condensed, if necessary, with pluggers similar to Figs. 470 and 471.

As a general rule, filling a cavity in the grinding surface of an upper

molar or bicuspid is an exceedingly simple operation, requiring less skill than the introduction of a filling in any other locality in these teeth; but there are cases in which it is rendered very difficult, as, for example, when there are one or more fissures or carious depressions radiating from the main cavity. After the caries has been removed and the fissure enlarged, which was often a very tedious operation before the use of fissure burs with the dental engine, it requires considerable time and skill to fill these thoroughly. When it is not properly done, as is too often the case, a recurrence of the disease will soon take place, and thus defeat the object for which the operation was performed.

The introduction of a filling in the grinding surface of the second or third molar of a person having a very small mouth is sometimes attended with great difficulty; in some cases it can only be done with an instrument having a point bent nearly at right angles with the stem, like the one represented in Fig. 471; consequently, the power required for introducing and consolidating the gold is applied to great disadvantage. But the instrument represented in this cut is only intended for the first part of the operation of consolidating the metal; for its completion smaller points are required.


FIG. 471.

In filling a cavity in the grinding surface of a first upper molar on the left side of the mouth, the thumb of the left hand may be placed against the left cuspid or first or second bicuspid, as may be most convenient to the operator, while the forefinger is placed behind the point of the instrument and at the same time made to push back the commissure of the lips. To obtain a good view of the cavity in a second or third molar during the operation, the cheek should be pressed from the tooth with the forefinger of the left hand; but this finger can seldom be carried far enough back on this side of the mouth to be placed behind the point of the instrument. During the introduction of gold the instrument should be grasped as in Fig 463, or, better still, as in Fig. 467.

In filling a cavity in the anterior approximal surface of a right superior molar or bicuspid, the operation may be commenced by placing the gold against the palatine wall and ending at the buccal. But before the process of condensing is commenced every portion of the surface ought to be thoroughly tested with a wedge pointed instrument, and wherever the point can be forced into the gold the cavity thus formed should be filled. The instrument employed for the introduction of the gold may be like the one represented in Fig. 466, but having a rather longer point and grasped as in Fig. 463. For condensing the

extruding portions, either or both of the instruments represented in Figs. 460 and 464 may be used, as also the one employed for the introduction of the gold. During this part of the operation the instrument may be held as before, or as seen in Fig. 473, which permits a much greater amount of force to be applied than when held in any other manner.

FIG. 472.

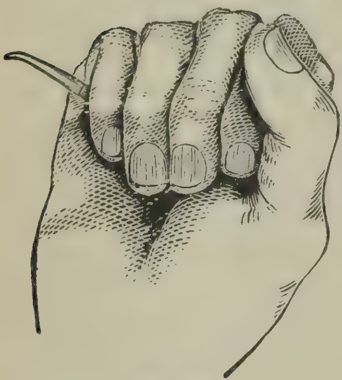


FIG. 473.

FIG. 474.

Nearly the same method and the same instruments are required for filling a corresponding cavity on the opposite side of the jaw. When practicable, the forefinger of the left hand should be placed on the palatine surface of the tooth, and the thumb against the buccal surface, and in addition to the instruments recommended for the right side of the mouth the one shown in Fig. 458 may be very conveniently employed to introduce the gold; also Fig. 460 or 474 in condensing the surface of the filling. The writer finds this last particularly valuable in very many cases.

A cavity in the posterior approximal surface of a superior bicuspid on either side of the mouth can, in the majority of cases, be as easily filled as one in the anterior approximal surface. The position of the left hand is very nearly the same, and in the introduction of the gold the first folds are placed against the palatine wall of the cavity. By commencing on this side the operator is enabled to lay the folds more compactly than he could were he to commence at any other point. He also has a more perfect control over the instrument in this part of the operation, and has a better view of the cavity during the introduction of the gold. For consolidating the filling, the instruments represented in Figs. 459, 460, and 465 are as well adapted to the purpose as any that can be employed.

When the mouth of a patient is large, a filling can often be introduced with nearly as much ease in the posterior approximal surface of a first or even a second upper molar as in that of a bicuspid; but when the mouth is small and the cheeks fleshy, it often becomes a difficult and perplexing operation, although the same method is used; yet, as it is absolutely necessary to the introduction of a good filling that the operator should see the cavity and witness every part of the operation,

his ingenuity is often taxed to the utmost in contriving the most suitable means to enable him to do it. A number of instruments for drawing back the corner of the mouth have been invented, but the writer believes there are none so well suited to the purpose as the thumb or forefinger of the left hand of the operator. If the operator will accustom himself to the use of a small mouth-glass held in the left hand whilst operating, he will be spared many back-breaking efforts to keep in view fillings on posterior surfaces. It is necessary to become familiar with the apparently reverse motion of the instrument as seen in the glass; also to accustom the three fingers of the left hand to act independently of the thumb and forefinger. But one of the most careful and skillful operators of this or any other country, Dr. Maynard, assured us that he worked from a reflected view in the glass with the same ease as where he had a direct view of the cavity, and obtained, in very many cases where he used the glass, an accuracy of view which direct vision could not give him.

Before dismissing this part of the subject there is one point to which the attention of the young practitioner should be particularly directed. Many, in other respects tolerably good, operators are most likely to fail in not introducing a sufficient quantity of gold in the upper palatine portion of the cavity. The author frequently meets with cases in which the walls of the cavity are perfectly sound and every other part of the filling well consolidated; but here, upon the application of a wedge-pointed instrument, the gold is easily perforated. He would therefore advise the inexperienced operator to test this by severe pressure with a sharp, wedge-pointed instrument, as well, indeed, as every part of the filling, before leaving the operation. There is also one other precaution applicable to fillings in the approximal surfaces of the incisors and cuspids, as well as of the molars and bicuspids; it relates to overlapping portions of gold under the free edge of the gum, which must be carefully and completely removed before the operation can be regarded as complete.

In filling a cavity in the buccal surface of an upper bicuspid or molar, on either side of the mouth, the gold may be introduced with the instruments represented in Figs. 456 and 466. The latter is better adapted for the left side, but may also be used on the right. The straight, wedge-pointed instrument may also be advantageously employed on this side. The first folds of gold should be placed against the posterior wall, proceeding from behind forward, and pressing the folds against each other as compactly as possible. When the cavity has a large orifice and is rather shallow, or in other respects badly shaped for the retention of the gold, the operation is often tedious, difficult, and perplexing. But under favorable circum-

stances a filling may be almost as readily introduced here as in any other part.

The palatine surface of a bicuspid or of a molar is rarely attacked by caries; on the latter it is usually seated in a depression at the termination of a fissure leading from the posterior depression in the grinding surface. It is usually situated near the posterior palato-approximal angle of the crown, about half way between the gum and the coronal extremity of the tooth. It sometimes happens that the walls of these fissures are affected with caries throughout their whole extent, requiring to be filled from the depression in the grinding to its termination on the palatine surface. In this case the portion of the cavity on the grinding surface may be first filled; then the operator may proceed to fill the palatine portion in the same manner as if it were a simple cavity, placing the first folds of foil, in the case of a right molar, against the upper and posterior side of the opening with an instrument like the one represented in Fig. 466. Great care is necessary to prevent the instrument from slipping. It often happens, too, that the orifice becomes choked with foil before the cavity is half filled. This, indeed, is liable to occur in filling any cavity in any tooth; and when it does happen, unless a sufficient amount of pressure is applied to make a free opening into it, the filling will be imperfect and the object of the operation wholly defeated. When the cavity is situated in a left molar, the gold may be introduced with the instruments represented in Figs. 456 and 469, placing the first folds against the upper wall of the cavity and proceeding downward.

A tubercle of greater or less size is sometimes found on the anterior palatine surface of a molar, near the crown. Between this and the body of the crown a deep impression is often seen, which becomes the seat of caries; but the removal of the diseased part and the introduction of a filling is so simple that a special description of the operation is not deemed necessary.

II. *With Cohesive Gold Foil.*—In forming cavities in the approximal surfaces of the bicuspids and molars it is essential, in the majority of cases, to separate the teeth either by means of pressure or by cutting away a portion of the crown.

When they are very close together it is often impossible to gain sufficient space by pressure, and it then becomes necessary to resort to the enamel chisel, file, or disc, cutting away a portion from each tooth when both are decayed, and from one only if the other is in a sound condition. The former practice in separating these teeth was to cut away so much of the entire approximal surface as to form a V-shaped space of sufficient extent to enable the operator to reach the cavity easily. But by this method the crown of the tooth

was disfigured and a space formed in which food readily collected and became a source of considerable annoyance. To avoid this, the practice now is to cut through the grinding surface to the approximal cavity, mortising this opening, and thus preserve the palato- and bucco-approximal angles, while at the same time the shape of the opening through the grinding surface materially assists in the retention of the filling. In preparing these cavities for cohesive gold foil, at least two good retaining points should be made at the cervical wall and two under-cuttings at the cusps, which have been preserved by the method of gaining space just described. But one of these retaining points, in connection with the two under-cuttings at the cusps, will often secure the filling when the nature of the case will not allow of more being made.

In preparing a cavity on the posterior approximal surface of a molar tooth, access is obtained by cutting through the grinding surface in the manner before referred to; then, by means of instruments

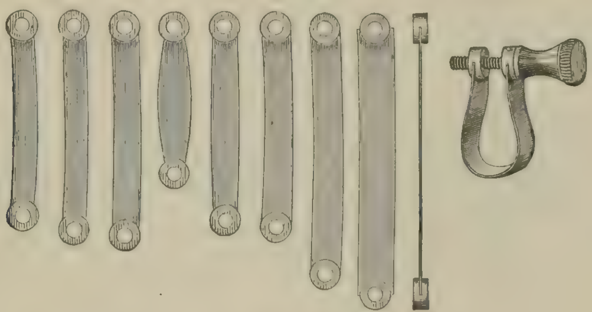


FIG. 475.

more or less curved, the buccal and palatine walls are made parallel with each other, under-cuttings formed at the cusps, and retaining points drilled in the cervical wall at different angles. Advantage is also gained from having the cervical wall slightly undercut. In introducing the gold into a cavity of this nature many prefer placing a polished plate of metal or a matrix back of the cavity, in the space between the teeth, and condensing the gold firmly against it in building up this portion of the crown. By this method a good support is obtained, and after all the gold necessary is introduced and consolidated the metal plate is removed.

Fig. 475 represents a set of loop matrices, consisting of thin, flexible steel bars and a milled thumb-screw. To use them, one of the proper size is selected, the head with the smooth hole being passed over the thumb-screw; the screwed head is then bent around and the loop screwed to its place on the tooth.

Fig. 476 represents an ingenious matrix invented by Dr. Louis Jack. *a* shows the concave and wedging sides of the matrix, and *b* shows a matrix placed between two teeth ready to wedge and fill. *c* represents the form of pliers for placing a matrix in position.

The points especially notable in the use of a mátrix are, to cut away the masticating surface of enamel to the depth of the cavity; to prepare the edges flat and smooth; to cut down to sound structure in

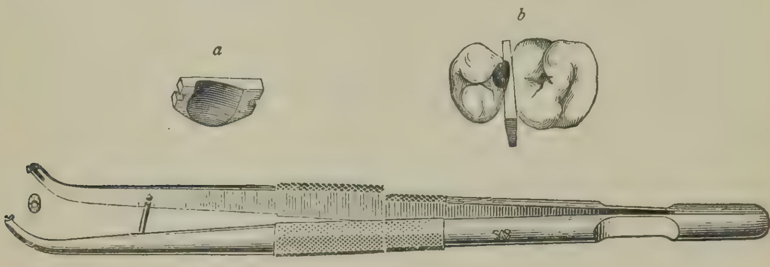


FIG. 476.

the neck of the tooth, forming the base of the cavity, and shaping it so that the matrix will fit accurately on the cervical wall. Having excavated the cavity and cut a retaining groove along the buccal and palatal walls (terminating at the very surface of the masticating walls of the enamel), select a matrix the concaved surface of which matches the cavity. Then, after applying the rubber dam, finish and dry the cavity, place the matrix, and secure it with wedges of boxwood, which, being hard and dry, require very little forcing. The filling

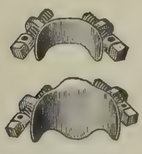


FIG. 477.

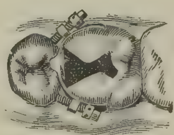


FIG. 478.

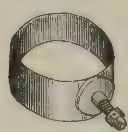


FIG. 479.

may be then done with the ease and certainty of a crown cavity with strong walls.

Figs. 477 and 478 represent the double screw matrices designed by Dr. W. A. Woodward, which, like those of Dr. Jack, occupy a single interdental space.

Figs. 479, 480, 481, 482, and 483 represent Dr. T. W. Brophy's matrices and their use in the forms of bands and screws.

Soft or non-cohesive foil should be used for the cervical margins and for the first half of the filling, because of the ease with which it

may be adapted to the cavity walls and the rapidity with which it may be inserted; the masticating surface to be finished with cohesive gold. Wedge-shaped pluggers are the most desirable forms with which to condense the soft foil. If amalgam or cement be used the band

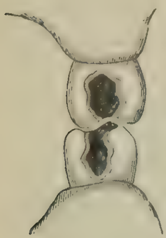


Fig. 480.

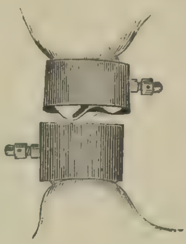


Fig. 481.

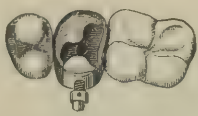


Fig. 482.


Fig. 483.

should be oiled on the inner surface, to prevent the filling from adhering to it.

Figs. 484 and 485 represent Dr. W. B. Miller's matrices and their use. This matrix is commonly held firmly in place by reason of its duplex


Fig. 484.


Fig. 485.

spring expansibility, but it may be additionally supported by a wedge of wood driven between the springs. Either the concave or convex edges go next to the gum, according as the cervical margin of the cavity is upon or beneath the gum, and a thick or thin matrix will be indicated by the width of the space between the teeth.

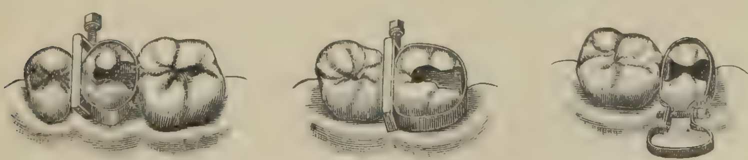


Fig. 486.

Dr. Guilford's band matrices and clamps are represented by Figs. 486, 487, and 488.

The Herbst matrix consists of a band of soft German silver, of the thickness 32 Am. gauge, about one inch and a half in length, and as

wide as is necessary to cover the cavity in the proximate surface of the tooth. It is first fitted to the crown by bending it around, bringing both ends of the band to the buccal surface, and drawing them tightly together by the pliers. When the band is thus made to fit perfectly to the crown of the tooth to be filled, it is carefully removed and the joint soldered with soft solder, using muriate of zinc solution as a flux. This matrix is prepared before excavating the cavity.

FIG. 487.

For the use of gold by the Herbst method, matrices are also employed made of gum shellac, which is molded to the tooth crown in a plastic condition, and then trimmed to the proper shape so as to form a supporting wall and not interfere with the introduction of the gold.

FIG. 488.

"Dr. Perry's matrix consists of a strip of metal to go about half way around the tooth and having a hole drilled through each end (Fig. 489). It is fastened around the tooth by means of a threading cord of floss silk, which is passed through the holes and tied fast with a double or treble knot (Fig. 490). The knot can be pushed out of the way upon one side of the tooth. The usual fault with matrices of this character is that they are made in different parts, one or more of which is liable to fall upon the floor, and they are in other respects difficult to manage. This one is very simple. You pass the threads through the holes in the ends, place the matrix where you wish to have it, wrap the thread around the tooth, and tie it (Fig. 491). If it

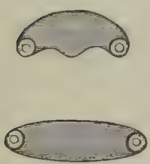


FIG. 489.

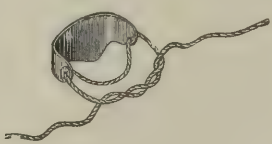


FIG. 490.

FIG. 491.

stretches a trifle there is no harm done, because in packing gold there is a greater certainty of a close fit at the margins if the matrix yields a little. The matrix is made of very thin steel, and to prevent it from cutting the thread with which it is tied small pieces of metal are soldered to the ends, and the holes for the thread are drilled through those extra pieces of metal. This makes it so thick and firm that the thread can be drawn tight without danger of cutting it. The matrix is not universal in its application, and it is well to have others; but it is, in certain cases, a very good device. The holes are drilled in

such a manner that the thread comes near the cervical wall, and the matrix is made to hug the tooth at that point. If it does not, a wedge of wood dipped in sandarac varnish and pushed between it and the adjoining tooth will cause it to fit well at the cervical border. This matrix is equally suited for gold or other plastics. It is particularly neat when amalgam is used, and it is often desirable to leave it on the tooth for a day or night. To avoid obstruction many narrow

FIG. 492.

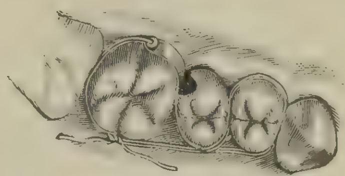


FIG. 493.

forms of this matrix may be kept on hand, some of which do not cover more than one-third or one-half the length of the tooth.

"There is another use to which the same matrix may be applied. It is that of adapting it by a simple method of binding and tying to any of the other teeth. Reference to the cuts will show how it can be easily applied to the incisors, which almost always should be filled from the lingual side (Fig. 492), and to the bicuspids and molars (Fig. 493), which can be sometimes filled from the buccal or lingual side

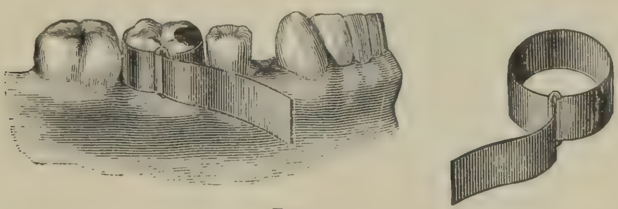


FIG. 494.

without cutting down from the grinding surface. To one who reveres the shapes of the teeth this is an operation that is most satisfactory, and by the aid of this simple matrix it is more easily performed."

Fig. 494 represents the Weirich single band metal alloy matrix with a loop at the end.

To apply the matrix, place the band between the teeth, bringing the loop to the buccal side of the tooth to be operated upon ; pass the other end through the loop, drawing the band close around the tooth, then bend it sharply back on the loop and it will remain firmly in place.

To remove the matrix, merely reverse the movement, straighten the band, and slip it off.

Split teeth may be secured by gold bands or collars used in connection with oxychlorid or oxyphosphate of zinc between the fractured surfaces.

"Large contour restorations may be expeditiously made by means of the collars set tightly on the thoroughly prepared and dried tooth, which can then be filled with gold or gutta-percha or cement. For cutting the collars to conform to the cervical curves, an engine corundum point or Herbst rotary file will serve the purpose, and a collar so cut is shown by Fig. 495. To keep the gold as much as possible out of view, the collar should be cut as seen in Fig. 496. Platinum collars will be required when the filling is to be of amalgam, but a gold collar may be varnished with a mere film of collodion, copal, sandarac, or shellac varnish, at the part which is to come in contact with the amalgam, and then with proper care a dry amalgam will not combine with the gold of the collar. A thin collar, somewhat larger than the tooth, can be put in place, and a wedge of wood driven between the remaining portion of the tooth and the collar, to form a matrix, which,

FIG. 495.

FIG. 496.

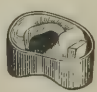


FIG. 497.

after the filling has been built in it, can be removed by first withdrawing the wedge. Such a matrix is illustrated in Fig. 497, and by this means many large and complex fillings may be rapidly and perfectly constructed."

In filling grinding surface cavities in the molar teeth, where the decay has extended along one or more of the crown fissures, with cohesive gold foil or crystal gold, the gold is first introduced into the bottoms of the crown fissures and built up to their orifices, thus completing the filling of these fissures before the central cavity is filled. The fissures or sulci should be opened to their extreme limits and the ends be made round. Small curved chisels and fissure-drills are well adapted for preparing sulci, and the excavation should be commenced at the central part. In preparing cavities extending in the form of sulci or fissures over the buccal and palatine surfaces of the bicuspids and molars, all projecting portions of enamel should be cut away, so as to allow these cavities to be but little larger within than at their orifices; and the ends of the groove, which are usually shallow, should be made as deep as the center. One retaining-point may then be

made in each of the two walls forming the ends of the groove-like cavity, or one retaining-point in the posterior wall, in connection with an under-cutting in the anterior one, will answer for the retention of the filling. In introducing the gold into a cavity of this form the retaining-points are first filled and the gold built across the floor of the cavity from one to the other, and from the base thus formed to the orifice. When a cavity upon the buccal or palatine surface extends under the free margin of the gum, it is necessary to either force the gum away by pressure with pledgets of cotton saturated with chlorid of zinc, when the cavity is not too near the pulp, or to remove the portion overlapping the cavity. The hemorrhage which follows this latter method may be checked by any of the hemostatic agents in use, such as tannin, phenol sodique, creasote, powdered subsulphate of iron, etc.

The application of chlorid of zinc will prove very effectual in such cases; also nitrate of silver, but the latter agent has a tendency to discolor the dentine.

FILLING THE INFERIOR INCISORS AND CUSPIDS.

The operation of filling a lower incisor or cuspid is far more difficult than filling an upper.

The constant tendency of the lower jaw to change its position is embarrassing to the dentist in operating on any of the teeth in it, and in case of the incisors and cuspids it is sometimes peculiarly perplexing. To prevent this all the effort the operator can make with his left hand is frequently required. From the backward inclination, too, of these teeth, it rarely happens that the gold can be introduced from the lingual side of the arch; consequently it is necessary to make the space as wide anteriorly as posteriorly. But as the teeth are comparatively small, the separation, when made with a file, chisel, disc, etc., should be no wider than absolutely necessary for the removal of the diseased part and the introduction of the gold. When, however, it can be done with safety, the separation should be made with a piece of rubber or other substance between the teeth, in the manner before described, or by rapid separation.

While operating on the lower teeth the head of the patient should occupy a more perpendicular position than while operating on the upper; this may be done either by lowering the seat or raising the head-piece of the chair. When by the latter it will be occasionally necessary for the operator to stand upon a stool five or six inches in height.

In filling a cavity in the right approximal surface of a lower incisor or cuspid with *non-adhesive gold foil* the following method is recom-

mended. The cavity being prepared and a sufficient quantity of gold foil made into a small roll or folded lengthwise, as the operator may prefer, with the left arm over the patient's head, the chin is gently grasped with the left hand, while the thumb is placed against the lingual surface of the tooth, the forefinger serving to direct the gold and point of the instrument and also to depress the lower lip. The folds of gold, in their introduction, are pressed firmly against the lower wall of the cavity. The instrument employed for this purpose may be shaped like the one represented in Fig. 498, with a very small, wedge-shaped point, and held as in Fig. 467. The consolidation of the gold may be effected partly with the same instrument, partly with a round-pointed one shaped as shown in Fig. 499, and partly with an instrument shaped as in Fig. 465. The tooth should be firmly held between the thumb and forefinger of the left hand, to prevent it from being moved in its socket by the pressure of the instrument.

When the incisors are very small and the caries has spread over a large portion of the side of the tooth, it is often difficult to form a suitable cavity for the retention of the filling without penetrating to the pulp-cavity. In such cases the patience and skill of the operator

Fig. 498.

Fig. 499.

are frequently taxed severely in obtaining a sufficiently secure support for the gold. But this he can usually do if he can make the bottom of the cavity as large as the orifice, even though it have but little depth.

The manner of introducing a filling in the left approximal surface is very similar. The left arm and hand, as well as the thumb and forefinger, are all disposed of in the manner just described. The same instruments, too, may be employed for introducing and consolidating the gold, though in the first part of the operation the instrument, Fig. 461, may often be advantageously substituted for the one in Fig. 498. The instruments known as "rights and lefts," of different sizes, are very serviceable for filling all approximal cavities.

Nothing has been said with regard to fillings in the labial or lingual surfaces of lower incisors and cuspids. Although caries rarely attacks either of these surfaces of a lower incisor, it does sometimes develop itself in the labial surface of a cuspid; but the operation of introducing a filling here is so simple that a separate description of the manner of it is not deemed necessary.

The operation of forming cavities in the inferior teeth and introducing *cohesive gold foil* and *crystal gold* is the same as that described

for the superior teeth, and a second description is therefore not considered necessary. As absolute dryness is essential in manipulating the cohesive forms of gold, the reader is referred to the various methods and appliances before described for drying cavities and protecting them from moisture. In filling the inferior teeth, the rubber coffer-dam will be found to be a valuable appliance for excluding all moisture from both the gold and cavity, and the saliva-pump an efficient adjunct to this dam for relieving the mouth of the saliva as it accumulates in prolonged operations. For controlling the movements of the tongue, a tongue and duct compressor has been used in connection with pads of bibulous paper placed upon the mouths of the ducts beneath the tongue. Prepared spunk has also been used successfully on the mouths of the sublingual and submaxillary ducts for controlling the flow of saliva. The rubber dam, however, will answer all requirements when used in connection with clamps.

FILLING THE INFERIOR MOLARS AND BICUSPIDS.

In filling a cavity in the grinding surface of a right lower molar or bicuspid, the operator may stand on the same side of his patient and a few inches higher than while operating on an incisor or cuspid. With his left arm placed over his patient's head, the tooth may be grasped with the thumb and forefinger of the left hand, while the middle finger is placed by the side of the chin; the other two should be placed beneath it. After preparing the cavity, *non-cohesive gold foil* may be introduced with an instrument like the one represented in Fig. 469, and held as shown in Fig. 463, pressing the folds against the posterior walls of the cavity.

In condensing the gold after the cavity is filled, use the instrument represented in Fig. 470. Sometimes, however, a greater amount of force can be exerted when this instrument is held in the manner shown in Fig. 473, previously wrapping it with the corner of a napkin to prevent the small part of the instrument from hurting the little finger. *The kind of instrument and the manner of holding it will, after all, have to be determined by the operator.* During the introduction and consolidation of the gold the lower jaw should be firmly held with the left hand, to prevent it from moving and from being too much depressed. This precaution is the more necessary, as the muscles of the lower jaw and the articular ligaments are seldom strong enough to resist the amount of force required in the operation.

In filling a cavity in the grinding surface of a tooth on the left side the dentist may sometimes operate to greater advantage by standing on the same side. In this case the commissure of the lips should be pressed back with the thumb of the left hand, placing it on or

against the tooth to be filled, while the forefinger passes in front of the chin and the other three beneath it. As a general rule, however, he will be able to operate more conveniently by standing on the right side of his patient and holding the tooth and the chin in the manner before directed. In either case, the gold, in its introduction, should be pressed against the posterior wall of the cavity.

The foregoing general directions will be found, for the most part, applicable to the introduction of a filling in the approximal surfaces. When the crowns of the teeth are long and the cavity situated near the gum, the operation is sometimes very difficult and tedious, requiring all the patience and skill the dentist can exercise to accomplish it securely. This difficulty is increased when the shape of the cavity is unfavorable for the retention of the gold; or, in other words, when the cavity is shallow and has a large orifice. There is also another very serious difficulty which the operator encounters in the introduction of a filling in the approximal and also in the buccal surface of a lower molar or bicuspid. The flow of saliva is often so profuse that the whole of the lower part of the mouth is completely filled, and the tooth is inundated before it is possible to introduce a sufficient quantity of gold to fill the cavity. This not only retards the operation, but it also renders it more difficult and perplexing; for it is necessary to force out every particle of moisture from the cavity and from between the different layers of gold before the necessary cohesive attraction between them can be secured. If this is not done or, at any rate, if all the moisture is not forced from the cavity, and the gold sufficiently consolidated to render it impermeable to the fluids of the mouth, the operation will be unsuccessful to a great extent; hence the rubber dam is a valuable adjunct.

Ordinary foil (non-cohesive), when introduced in folds lying parallel with the sides of the cavity, keeps its place by the close lateral contact of the folds against each other and the walls of the cavity. Hence such fillings may prove successful, although done "under water," provided the lateral pressure is sufficient to force out the saliva from between the layers of foil. But if the folds are laid in parallel with the bottom of the cavity, the operation will fail, in consequence of the scaling off of the successive layers which have no cohesion. Crystal gold and cohesive foil fillings depend for their success upon the perfect cohesion of their component pieces; therefore the slightest moisture, or even dampness, while being introduced is fatal to their durability.

For the purpose of obviating this difficulty a variety of means have been proposed, the most important of which have already been described and need not be again referred to.

In the introduction of non-cohesive gold on the right side, it may be pressed against the buccal wall of the cavity on the left side, or against the lingual wall. Either of the instruments represented in Figs. 455 and 456 may be employed for the introduction of the gold, whether the cavity be situated in the anterior or posterior approximal surface of the tooth, and may be held in the hand in the manner shown in Figs. 463 and 467.

In filling a cavity in the lingual and posterior approximal angle of a first or second bicuspid, and especially from the loss of the tooth behind it, when there is a backward inclination of the organ, great care is necessary to prevent the instrument from slipping and wounding the lower lip. The most convenient position for the operator in this case is on the left side and partly in front of the patient. The tooth may then be firmly grasped between the thumb and forefinger of the left hand, or the thumb alone pressed against the outside of the tooth; in either case it is to be used as a rest for the ring finger of the right hand during the introduction and consolidation of the gold. But the locality of the cavity is such, especially when the mouth of the patient is small, that it can only be seen with great difficulty. Hence the operator is constantly liable to place the point of the instrument on one side of the orifice against an overlapping portion of gold, which, when pressure is applied, is cut through or detached. The instrument thus comes in contact with the hard, smooth enamel, and unless the hand is so guarded as to control its motions it is liable to slip and wound some part of the mouth, especially the lower lip, which accident, unless proper precaution is observed, may occur in filling any tooth.

Among the principal difficulties which the dentist encounters in filling a cavity in the buccal surface of a lower molar, apart from that of keeping the cavity dry until the gold is introduced, is the contact of the lower and inner part of the cheek with the tooth. This may, to a considerable extent, be prevented, and the commissure of the lips at the same time pushed back with the forefinger of the left hand of the operator, which also will serve, when the cavity is shallow and the orifice large, to hold the gold in place until a sufficient quantity is introduced to obtain support from the surrounding walls. In operating upon the bicuspids it is only necessary to depress the corner of the mouth to obtain free access to the cavity.

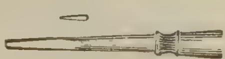


FIG. 500.

For the introduction of the gold on the right side, either of the instruments represented in Figs. 456 and 466 may be employed, but on the left side the latter will generally be found most convenient. A straight, wedge-pointed instrument (Fig. 500) can often be advantageously used in introducing the foil in either of the right bicuspids, and sometimes

even in the first molar. This instrument can also often be used in filling a cavity in the grinding surface of a molar of either jaw, but oftener in the upper than the lower. It is scarcely necessary to say that the introduction of the gold should commence behind and proceed forward. The instruments represented in Figs. 459, 468, and 472 may be used in consolidating the foil.

It may be well to mention here that in filling a molar or bicuspid on the left side in the lower jaw, whether in the grinding, approximal, or buccal surface, the back of the chair, if so constructed as to admit of being moved, should be thrown five or six inches further back, to lower the head of the patient and give the face a more horizontal inclination. By this means the operator is enabled to approach the locality of his manipulations with greater ease, thus enabling him to exercise a more perfect control over his instrument, as well as over the mouth. But if the back of his operating-chair is stationary, he should stand upon a stool of five or six inches in height.

The precaution of removing all the overlapping portions of gold should never be omitted, and this sometimes constitutes a difficult part of the operation, especially when the cavity extends under the margin of the gum. For this purpose some of the files represented in Fig. 444 may be very advantageously used. Some are made straight at each end, others are curved. The cutting-burs operated by the dental engine, and also the corundum and sand-paper discs, are useful instruments for removing surplus gold.

The manner of building up the whole or a part of the crown of a tooth will now be described.

CONTOUR FILLINGS.

The term "contour" signifies "the line that bounds, defines, or terminates a figure; hence a "contour filling" is one that is made to conform to the line that defined the contour of the lost tooth tissue; in other words, the filling material is built up to such a degree as is necessary to restore the original form of the crown of the tooth.

It is scarcely to be expected that any one who has not had considerable experience in filling teeth, and acquired a high degree of dexterity in the use of instruments and the working of some one or more of the preparations of gold employed for the purpose, such as cohesive gold, will, simply from any directions that can be laid down upon the subject, be able at once to perform the operation of building on the whole or part of the crown of a tooth. But it is hoped that the following description may serve as a guide to those who have never attempted it, and may wish to exercise their mechanical and artistic abilities on this, the most difficult of all operations in dentistry.

Those only who are aiming at high excellence in this department of practice will be likely to undertake it; and should their first efforts prove unsuccessful, the increase of skill they will have thus acquired in the use of instruments will inspire new confidence, and ultimately, by perseverance, enable them to achieve the object of their wishes.

The operation, to be successful, must not only be performed in the most perfect manner, but the tooth itself must be situated in a healthy cavity and firmly articulated. Under other circumstances it would be useless to attempt the restoration of the organ. The general system, too, should be free from any preternatural susceptibility to morbid impressions.

A tooth on which this operation is called for has, in nearly every case, suffered so much loss of substance as to render it necessary, in cases where the pulp of the tooth is not exposed, that great care should be exercised in preparing the cavity for such a large mass of filling material, especially gold, and securely anchoring it. Where the exposure of the pulp of the tooth necessitates the destruction and removal of this organ the operation of "contouring" is much less difficult, as the pulp-chamber affords secure anchorage for the filling. Where the pulp has previously perished from inflammation and suppuration, the permanent preservation of the organ cannot be counted on with as much certainty as when it is destroyed by extirpation or by the application of an escharotic two or three days before the performance of the operation. Its destruction by the suppurative process is more apt to be followed by alveolar abscess: and this, having once established itself, must be completely cured, to prevent the liability to its recurrence. Hence, if the operation is determined on, the parts of the extremity of the root must first be restored to health; for without this it should never be attempted. The preparatory treatment in cases of this sort, as well as in cases of simple morbid secretion escaping from the root, is given in another chapter.

In describing the operation we will commence with the first molar of the left side of the superior maxilla. We will suppose that about three-fourths of the crown has been destroyed by caries and that the buccal wall is the only portion remaining, the pulp being more or less exposed. This is to be destroyed and extirpated to the extremity of each root; the decayed portions of the tooth are then to be removed, and the central chamber enlarged until the wall of dentine on the palatine, anterior, and posterior approximal sides are only about one line in thickness. On the inside of this wall a shallow groove or undercut is made and also retaining points, to give additional security to the gold.

The tooth as now prepared is represented in Fig. 501, and, after

the application of the rubber dam, is ready for the introduction and building on of the gold. But before describing the manner of doing this it may be well to say a few words with regard to the preparation of gold most proper to be employed. For filling the roots, non-cohesive gold foil is the best. If the leaves are thick, weighing from fifteen to twenty grains, it should be introduced in very narrow strips, without folding, in the manner described in another chapter; if leaves of four or six grains are preferred, it may be cut in strips varying from an eighth to a quarter of an inch in width, according to the size of the canal in the root, and then rolled or made into very narrow folds. For the central chamber and crown, gold possessing cohesive properties should be employed; although this property may, to a degree, be imparted to common gold foil by slightly annealing immediately before using, cohesive gold foil possesses it in a higher degree, and this also requires to be annealed. Either kind of foil, therefore, or crystal gold may be employed. The operation, however, can be better performed with the cohesive foil or crystal gold than with the non-cohesive foil. Crystal gold is often used to fill the central chamber and act as a base upon which to build the cohesive gold foil.

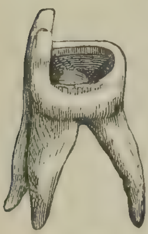


FIG. 501.

As the manner of filling roots is described in another place, we shall commence with the pulp cavity. The gold, supposing it to be cohesive foil, is loosely rolled into a fold or rope, from which pellets are cut. A sufficient number of these having been prepared, the surfaces against which the gold is to be placed are made perfectly dry by wiping with Japanese bibulous paper or absorbent cotton. This done, one of the pellets is placed in the central chamber with pliers, pressed into a retaining point, where the formation of such points is necessary, and consolidated with a small-pointed condensing instrument; another and another is added, each being consolidated as the first, until a sufficient number have been introduced to fill this chamber. The process of consolidation is now to be repeated and continued until no part of the gold can be made to yield to the pressure of the instrument; then additional pellets are applied and condensed as in the first instance, forcing those placed against the surrounding wall firmly and compactly into the groove or undercut made in it, thus securing for the entire mass the greatest possible stability. Again, pellet after pellet is applied, pressing those placed along the outer edge firmly against the enclosed margin of dentine and against the buccal wall of the tooth, until a solid mass considerably larger than the portion of the crown to be supplied shall have been thus formed. The same result may be obtained much more rapidly by using the gold in the

form of a ribbon. In this case fold after fold of the gold is introduced, each fold being thoroughly welded and consolidated as introduced.

For the complete solidification of every part of the gold and the welding of every piece to the adjoining ones, a number of instruments are required, with serrated points, which are represented in the figures illustrating the instruments employed in the use of the cohesive forms of gold. For some parts of the operation a straight instrument can be employed most advantageously ; for other parts, one slightly bent near the point ; and for others, one bent at right angles with the stem. The kind most suitable for each case must be determined by the judgment of the operator. One, perhaps, may use very efficiently an instrument in a particular locality and for a certain purpose, that another, for the same purpose, would handle very awkwardly. But for completing the work of consolidation, all agree that very small-pointed instruments are indispensable. The consolidating or building instruments may consist of Varney's hand-mallet pluggers, or the points of the automatic or engine mallets.

As the cohesiveness of the gold is destroyed by the contact of liquids, it must be kept absolutely free from moisture during the entire process of introducing and consolidating the metal. But if, notwithstanding every precaution, the saliva should come in contact with the gold before its complete introduction, the unfinished surface must be thoroughly consolidated, then dried with some good absorbing substance, scraped, burnished, dried again, and made rough with a sharp-pointed instrument. To this surface fresh portions of gold can now be united, and sometimes made to adhere quite firmly, but often it is necessary to drill retaining points into the gold and continue the operation from these points. The use of the rubber dam and other appliances now enables the operator to perform prolonged operations without the danger from moisture which formerly existed.

The next step is to consolidate thoroughly every part of the surface. This may be commenced with the larger-pointed instruments. After going over it ten or a dozen times with these, smaller points may be used, and these again changed for still smaller, until no more impression can be made upon it than upon a solid ingot of pure gold.

It now remains to cut the surface until the gold is made to assume very nearly the shape of that portion of the original tooth the loss of which it supplies. The plug-finishing burs operated by the dental engine, the files for finishing the surface of fillings, and the corundum and sand-paper and stone discs and points, will be found serviceable for such operations. In doing this an opportunity is afforded to the operator for the display of much artistic skill and ingenuity. While

shaping the grinding surface the patient should be requested, from time to time, to close the mouth, that the depression in it may be made to correspond to the cusps of the tooth with which it antagonizes, so that these two may touch simultaneously with the other teeth of the upper and lower jaws. This part of the operation is always tedious, usually requiring more time than for the consolidation of the gold. The use of articulation paper may facilitate this part of the operation.

The surface of the gold may now be rubbed with properly shaped pieces of Arkansas or Hindostan stone or with pulverized pumice until all the scratches left by the files are removed; then polish with crocus and a burnisher. The appearance of the tooth as thus restored is shown in Fig. 502.

FIG. 502.

As it is impossible to perform the entire operation at one time, it may readily be divided into three parts, the *first* consisting in the extirpation of the pulp (when necessary) and the preparation of the tooth, the *second* in the introduction and solidification of the gold, the *third* in giving to the metal the proper conformation and in finishing the surface. The time required for the first, supposing the operation to be like the one just described, may vary from one and a half to two and a half hours; for the second, from two to three and a half hours; and for the third, from two to six hours, according to the difficulties to be encountered, the ability of the dentist, and the completeness of his preparation for the operation. Some, perhaps, may prefer crystalline or sponge gold, supposing it to be more easily welded than cohesive foil; but as the manner of working this variety of gold has already been described, it will not be necessary to give additional directions for its use.

The late Dr. M. H. Webb, an expert operator in contour work, gave the following directions for completing such an operation:—

"When the foil has been prepared and impacted as described, and so that the substitution for the lost tissue is complete, a fine saw or suitable file should be used to cut away the surplus material and to aid in making the filling conform to the original contour of the part, after which narrow strips (a line or ⅛-inch wide) cut from fine emery cloth should be so manipulated as to properly form and finish the surface of the gold. When this has been done and the rubber dam removed, the finishing should be completed by the use of fine pumice and silex upon linen tape, as before suggested. The gold at the masticating surface should be finished with fine burs, and by their use made concave or to conform to the original type of the part operated upon. The gold should be so impacted as to be flush with the prepared margin of

enamel, yet even then made concave when such concavity is indicated. Fine burs should be used for the purpose of trimming and shaping such fillings, because the form of the remaining part or parts of the cusps and prepared edges of enamel against which the gold is placed may be changed and the teeth made less useful when corundum cones are used. The polishing of the gold upon the surface referred to may be done with pumice and silex, mounted upon suitably shaped points of wood, leather, or rubber.

"Whether the cavity is large or small, the gold ought to be built out to the original contour of the part and at its periphery, a little beyond the margin, then finished down to the surface of the enamel, and the whole filling made to conform to the line that defined the contour of the lost tissue. If the gold be not impacted against, and be not flush with, the edges of the enamel, the operation is not such as is demanded for the preservation of remaining tissues. A plain surface of gold should not be made, because the tooth thus operated upon and the one adjoining may approximate closely and disintegration of enamel take place near or at the part in contact. Restoration of contour prevents such contact, and this prevention is necessary, especially when the tissues of the organ operated upon are not fully calcified. When operations have been so performed as to entirely prevent fluids or semi-solids from entering between gold and the tissue against which it has been placed, the gold tint may be seen through the light walls or edges of translucent enamel soon after the removal of the rubber dam and completion of the operation. If an opaque or dark line or spot be visible at or near the parts where gold ought to be in contact with dentine and enamel, the operation has been imperfectly performed, and chemical action may soon follow and the entire filling prove a failure."

The operation of building on the entire crown of a tooth should be proceeded with much in the same way as just described for part of the crown. If too large pieces of either crystal gold or foil are used at one time, the surface will become crusted over by the pressure of the point of the instrument, and this will prevent, by any subsequent force that can be safely applied, its thorough consolidation. In this case the general mass will be more or less spongy and the operation imperfect. The dentist should be well assured, therefore, as he progresses with his work, that every successive layer is firmly adherent to the preceding one. To build up an entire crown requires more time; perhaps, also, more skill, as there is no wall of tooth substance to give partial support. In other repects it resembles the previous operation.

It was suggested by the late Prof. Austen, as a plan to avoid much of the tediousness of the second stage of this operation, to fill the

pulp cavity, inclosing in the center a screw-cut, notched, or double-headed pin, and carrying the gold over the edges of the cavity; make this surface somewhat irregular in shape, but finish it smoothly, and trim the circumference to the exact size of the tooth; take a wax or plaster impression of the surface, and fit to the plaster model a lump of gold, having in the center a hole larger than the pin projecting from the root; shape and polish it *out* of the mouth, then set it in place and secure it by filling with gold around the pin. If the color is not objected to a vulcanite crown could be very perfectly adapted in this manner; or a porcelain tooth could be made, hollow in the center, with pins or a dovetail to hold a thin layer of vulcanite, by means of which it could be fitted with perfect accuracy to the prepared root. Prof. Austen thought that in this way the root will be less injured, and the union between the gold and the root less disturbed than by the long-continued and severe pressure of the ordinary operation. While the artificial crown is being made he suggests a temporary gutta-percha crown to prevent any irritation from the projecting pin.

A large portion of the crown of a tooth may be built up with ordinary gold foil if it be of the best quality, but the cohesive preparations, either foil or crystal gold, are preferable. The manufacture, however, of porcelain crowns well adapted to all forms of teeth, as well as the introduction of porcelain facings, or sections of crowns, for attachment to remaining natural portions, afford many advantages in restoring the lost portions of the teeth over that of building up with solid gold. See Fig. 506.

We have endeavored in the foregoing description to point out the general method of procedure in the operation of which we have been treating. We have also noticed some of the precautions necessary to be observed; but unexpected difficulties are sometimes encountered, the peculiar nature of which it is impossible to anticipate. Few, however, are of so formidable a character that they cannot be overcome.

During the operation of building up a portion or the whole of a crown with cohesive gold, if, in condensing it, any part becomes displaced or fails to unite with that already introduced, it should be removed, otherwise the filling will prove defective; and this rule will apply to all fillings of this form of gold. Each piece, as it is introduced, must be firmly attached to that already in position, and no doubt should exist concerning secure anchorage. When a contour filling, which includes a portion or the whole of the masticating surface of a bicuspid or molar, has been properly inserted, and the gold built up flush with the margins of enamel, such a surface should be made to correspond to the original surface in form, by making it concave by means of the fine finishing burs or corundum points used with

the dental engine, when it may be polished with pumice and silex, applied by properly-shaped points of wood, rubber, or leather. In all such building up the gold should be carried beyond the margin and then cut down to the surface of the enamel, preserving the original contour of the part as much as is possible. By the aid of matrices the contouring of approximal surface cavities, especially posterior ones, is greatly facilitated, as they enable the operator to adapt and impact the gold in a perfect manner.

To retain the gold of contour fillings in large, saucer-shaped, and other forms of cavities, screws made of fine gold, securely anchored in the dentine, with free ends projecting above the surface around which the gold is built, are available.

Fig. 503 represents Dr. How's retaining screws and instruments for their introduction. A shows a cone-socket screw-driver with a sliding split tube which serves as an adjustable holder for the screw, in the end of which is a slot, such as the operator may readily cut with a No. 5 separating file. On placing the screw in the holder, the driver blade will enter the slot, as shown in partial section by B. C shows in its palatal aspect an incisor wherein the apical portion of the pulp chamber has been properly filled and the main portion drilled and tapped with an A tap and drill. The tap is so set in the tap-chuck as to be a gauge by which the screw-post may be cut as much shorter than the gauge as will let the screw, after it has been placed in the holder (see B) and carried to its place in the root, project as shown in C. D shows a molar in the palatal root of which a B screw has been likewise inserted. It is obvious that large contour fillings may be securely built around screw-posts thus firmly fixed in the roots of such teeth.

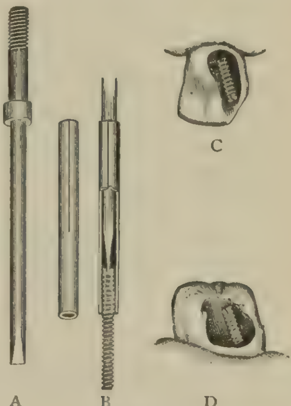


FIG. 503.

Fig. 504 represents Dr. E. Osmond's screws for securing gold fillings, with the instruments necessary for their introduction.

A A are screws made of 20-carat gold wire, annealed, split about half-way, once or twice, so as to form two or four arms when opened. B is a screw-driver, surrounded by a tube for the purpose of holding the screw and carrying it to its place in the tooth. C is a drill, for the purpose of drilling a hole, which is afterward tapped by the tap-screw D.

Figs. 1 and 2 are teeth with large saucer-shaped cavities, such as

we very frequently find; but other cases in which these screws are available will readily suggest themselves to the mind of the experienced operator.

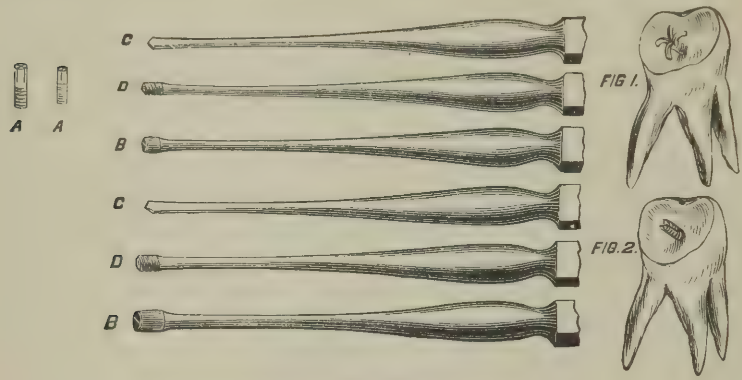


FIG. 504.

Fig. 505 represents the instruments for manipulating what is known as the St. Louis system of retaining screws.

In this set of instruments the drills, taps, and wire fitted for each other bear corresponding numbers, as 1, 2, 3.

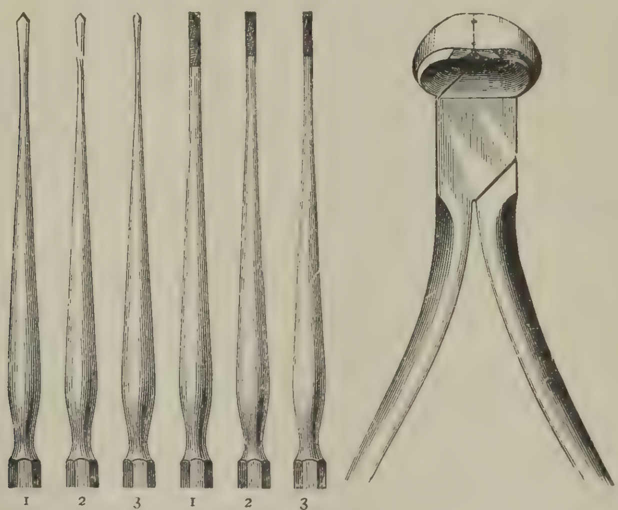


FIG. 505.

The wire-holder is made adjustable to take either size of wire.

The cutting edges of the cutting pliers are formed with two round openings, as shown in the cut. The long wire to be used, if put in

one of the openings, can be "nicked" at the proper distance to form the screw while in the wire-holder, so that after having been screwed into place it may readily be broken off without the use of file or pliers in the mouth.

Fig. 507 represents anchor screws, drills, and taps.

Cut No. 1 shows the size of the 18-carat gold anchor screw.

No. 2. Iridio-platinum anchor screw, same diameter, but longer than No. 1.

A. Anchor screw magnified to show thread and slot.

No. 3. The starting or center drill will form a pit at the exact point desired; but if this point be not at first obtained, the pit center may be moved laterally while the drill is revolving.

B. Point of center drill magnified.

No. 4. Limit or anchor drill; will bore only to the depth determined by the limit shoulder,—half the length of screw No. 1.

C. Point of limit or anchor drill magnified.

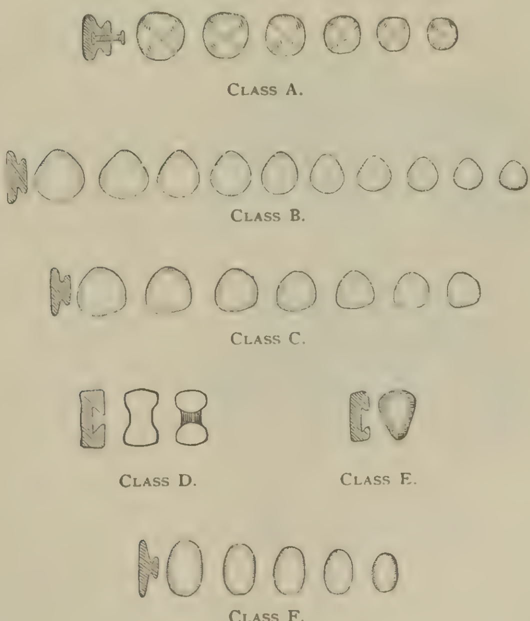


FIG. 506.

No. 5. Screw-tap, its diameter being only thirty one-thousandths (.030) of an inch.

No. 6. Screw-driver and sleeve which holds the screw for insertion or removal, as shown magnified at D.

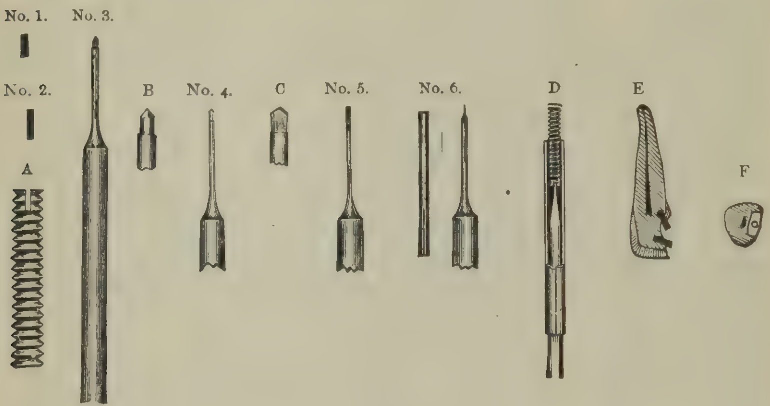


FIG. 507.

E and F exemplify the anchor screw in gold contouring operations. A drilled and tapped hole to be filled with gold foil serves as a superior retaining point.

Under the head of "Contour Work" reference may be made to the use of forms or facings of porcelain, as shown in Fig. 506, for filling cavities of decay.

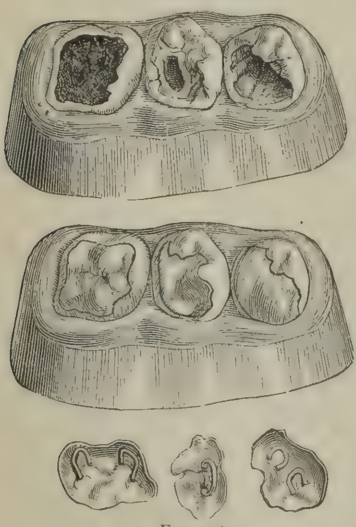


FIG. 508.

These are to be used in conjunction with oxychlorid or oxyphosphate of zinc, gutta-percha, or they may be set in amalgam. Used on an articulating surface, they have the advantage of a hardness at least equal to the most solid metal filling. They may also be used to avoid the display of more noticeable filling material.

For what is commonly called "bridge-work" the reader is referred to the article on "Preparation of a Natural Root and Attachment of an Artificial Crown."

Fig. 508 represents Dr. B. J. Bing's method of capping a carious or broken tooth. It consists in

properly preparing the walls of the cavity, and taking an impression of it with wax or modeling composition. Dies are thus obtained, upon which gold caps are struck. Small loops or rings are soldered to the bottom of the caps, which are secured in the cavities by gutta-percha or oxyphosphate of zinc.

Outfit of Operative Instruments.—A student's set of operative instruments may consist of a limited number of instruments, such as pluggers, chisels, scalers, foil carrier and plugger combined, excavators, dental engine instruments, pulp cavity pluggers, drills and extractors, files, syringe, Arkansas stone, foil shears, foil folder, mouth mirror, rubber dam, rubber-dam holder, rubber-dam clamps, rubber-dam clamp forceps, the hand or automatic mallet, chamois skin, orange wood, linen tape, burnisher. The heavy and expensive instruments, such as the dental engine, extracting forceps, and dental chair, are usually furnished by the dental schools. A number of dental chairs are in use at the present time, which combine all of the different movements required by the dental practitioner.

CHAPTER III.

FILLING TEETH OVER EXPOSED PULPS.

THE pulps of the teeth may be exposed by mechanical injuries and by caries; the first may occur from falls, blows, the careless excavation of carious cavities by means of the engine-bur or the excavator, while the latter is the result of the destruction and disintegration of the tooth-structure to such a degree as to expose the organ, which becomes irritated as a consequence, and, if the irritation is continued, leads to its suppuration, ulceration, and death. The propriety of filling a tooth after the invasion of the pulp-cavity by caries without first destroying the pulp was for a long time doubted by many practitioners. It was thought that inflammation and suppuration of the pulp must necessarily result from the operation. But Dr. Koecker, who was the first to recommend filling a tooth under such circumstances, cited a number of cases in which he performed the operation successfully.

The earlier attempts at capping exposed pulps were for the purpose of preserving the organ from the contact of air and from pressure during the introduction of the crown-cavity filling, and consisted in the medication of the pulp with creasote or a combination of creasote

and tannic acid, and later with carbolic acid, and its further protection by means of some form of cap.

The results, however, were unsatisfactory, and a correct method of treatment was first suggested by Dr. Keep, who employed a paste of chlorid of zinc, which was applied to the exposed pulp, which completely filled the space around the point of exposure, and thus prevented any receptacle in which effused serum or lymph could accumulate. The irritating effects of the chlorid of zinc, however, were such that this method was modified by substituting for the stronger zinc chlorid a weaker solution, which permitted its neutralization and thus diminished its power to irritate the pulp. Later, the oxyphosphate of zinc was substituted for the oxychlorid, the surface of the pulp being dressed with either pure or diluted carbolic acid.

The method of Dr. King, that of combining pure oxid of zinc with pure wood creasote, or carbolic acid, as a pulp-capping paste, which is flowed over or carefully applied to the pulp, has received a wide acceptance and given satisfactory results. This paste is covered with a layer of either the oxychlorid or the oxyphosphate of zinc, and the crown cavity filled temporarily with either of the zinc preparations, or gutta-percha, or Hill's stopping. A modification of Dr. King's method consists in first applying pure carbolic acid to the exposed surface of the pulp to produce a superficial coagulation, and then to cover it with a concave cap of platinum filled with the paste composed of oxid of zinc and equal parts of carbolic acid and oil of cloves, and then filling the remaining portion of the cavity with any of the plastic materials.

It is the practice of some to coat the surface of such concave caps in contact with the pulp with a solution of gutta-percha and chloroform, which acts as a non-conducting substance and is tolerated by the sensitive organ, owing to its anodyne and protective properties. The interposing substance may be held in place within the cavity by a delicate excavator or nerve instrument, and the oxychlorid, of thin consistency, flowed over it, when the remaining portion of the cavity can be filled with the same material in the form of a thicker paste. A portion of this material is afterward removed for the accommodation of a more permanent filling. Caps of tin of a thickness of No. 28, and of platinum No. 30, the concave surfaces filled with the paste of oxid of zinc, carbolic acid, and oil of cloves, or with a solution of gutta-percha and chloroform, and carefully applied over the point of exposure, will often prove serviceable in restoring the pulp to a normal condition. It is suggested that such caps be inserted edgewise, in order to prevent the direct pressure of the air or the paste on the sensitive organ. Over the metal cap a temporary filling is introduced

—one which requires little force for its introduction and of low conductivity. For such purposes the zinc preparations are commonly employed, although some prefer gutta-percha, tin, or amalgam. The zinc preparations when employed for such temporary fillings should not be neglected, owing to their liability to disintegrate near the margin of the gum. Asbestos, either alone or enclosed between layers of gold or tin foil, has also been employed as a capping, concave discs being formed when metal is used in combination with the asbestos, the inner surfaces of which are coated with the solution of gutta-percha and chloroform. Thin card-board paper, in the form of caps saturated with carbolic acid, has also been employed as an interposing substance between the point of exposure and a filling of the zinc preparation. Dr. W. C. Barrett has been successful in capping exposed pulps with the lactophosphate of lime, which is applied as an immediate cover to the exposed tissue, and which is prepared as follows: on a piece of glass or porcelain is placed a drop of Merck's lactic acid, to which as much magma phosphate is added as it will digest; it is then reduced to the proper consistency by adding the dry precipitated phosphate. The magma phosphate must be kept under water. It has been found that the lactophosphate of lime, prepared as above, is very congenial to the pulp.

Although bathing the exposed surface of the pulp with pure carbolic acid is practiced by many prominent dental practitioners, some contend that the escharotic action of the agent may prove injurious, and hence use either a diluted form, or the pure crystallized carbolic acid rendered fluid by a small quantity of chloroform; others assert that the results desired cannot be effected by a dilute solution of carbolic acid, owing to its greater affinity for water allowing it to be absorbed to a much greater degree, and causing more irritation and less coagulation than the pure form. It is very essential, in the treatment of cases of exposure of the pulp, that a due regard be paid to the condition of the organ, and the difference between normal and abnormal sensitiveness determined. If it is a case of simple exposure, after carefully preparing the crown cavity and the margin of the opening leading to the pulp, after syringing with tepid water, all moisture should be carefully removed, and a drop of the solution of gutta-percha dissolved in chloroform applied on the point of a delicate instrument (some prefer dilute tincture of aconite or a thin coating of glycerin or collodion), and the cavity filled temporarily with wax or cotton, the tooth remaining at rest for a few days and protected from irritation.

When everything has progressed favorably for such a period the operation of capping may be performed. Should the pulp be irritable or the seat of acute pain when first examined, the cavity should be

syringed out with tepid water containing a sufficient quantity of carbonate of soda to render the solution slightly alkaline. Such an application will relieve the pain, even if it is acute. The application of lead water is often useful for the same purpose, or the dilute tincture of aconite, or a solution of the sulphate of atropin.

Professor James H. Harris recommends the following method of treating teeth with exposed pulps: "First remove all decomposed dentine, for if any dentine in such a condition is allowed to remain, the progress of decay will continue and cause inflammation of the pulp, finally resulting in its destruction. Even if the carious portion *is* entirely removed and the pulp *not directly exposed*, we still need not be too confident of the ultimate preservation of the vitality of the tooth, for the *probability* is that the dentinal fibrillæ die in advance of the actual *decomposition* of the tooth substance, and hence, before the decay has actually reached the pulp, this organ may have assumed a condition from which recovery is impossible. Still, however, every attempt should be made to preserve the vitality of the pulps of the teeth, and with this object in view, having removed all of the decay, should any hemorrhage occur it may be arrested with spirits of camphor or with camphor and tincture of opium. The entire crown cavity should now be carefully filled with a *temporary filling* of Hill's stopping, avoiding undue pressure upon the pulp. The first piece of the Hill's stopping may be more safely adapted by first moistening it with chloroform.

"This temporary filling should be removed from time to time, as may be necessary, during a period of from one to five years, according to the health of the patient, extent of exposure, etc. With this treatment the reparative process will more readily go on, and when the pulp is found to have become protected by a layer of osteo-dentine a permanent metallic filling may be inserted.

"As a further precaution against danger to the pulp, a layer of Hill's stopping or of oxyphosphate of zinc may be placed in the bottom of the cavity and the permanent filling inserted over this. Sometimes, when the exposure is quite large, it will be found well to cap the pulp with a *thin mixture* of oxyphosphate of zinc, as this material can be more readily adapted to the exposed pulp without danger of producing undue pressure. But even when this method is pursued it is best to first coat the exposed surface of the pulp with a solution of gutta-percha and chloroform, in order to protect it from the slightly irritant effect of the oxyphosphate. The oxyphosphate first introduced should be mixed thin and allowed to harden, when the remainder of the cavity should be filled with the same material mixed stiffer, especially when the cavity involves the grinding surface, where a portion of the filling

is subjected to the friction of mastication. Sometimes, in large grinding surface cavities, after capping and filling the cavity two-thirds full of Hill's stopping or oxyphosphate, the filling may be finished with amalgam, which is permitted to remain as a test-filling for from three to six months, when, if no symptoms of pulpitis manifest themselves, such as paroxysms of pain caused by heat and cold, and gradually becoming constant, a portion of the temporary filling (about one-third) may be removed and the cavity filled with amalgam, which is allowed to remain, as before stated, from one to five years. Then the amalgam may be removed, and, if necessary for the support of the gold to be substituted, a small portion of the Hill's stopping or the oxyphosphate, and a gold filling inserted. In removing the temporary filling, preparatory to inserting a gold filling, the condition of the dentine should be carefully noted—whether it is normally sensitive or not, as the pulps of teeth often die from chronic inflammation without pain to the patient, in which case the dentine would be devoid of sensitiveness. Ossification of a pulp renders the dentine painless. During the removal of a portion of the temporary filling, should the dentine be found not sensitive, the operation of removing the temporary filling should be continued until the cause of such want of sensation be ascertained, whether due to the death of the pulp or its ossification.

"In performing the operation of 'capping' the rubber dam should be applied if possible.

"In the treatment of cases of exposure of the pulp a careful record should always be kept, as it is impossible to remember the peculiarities of each case extending through a long period of treatment."

Traumatic exposures of the pulp, or those which occur from accidents, such as fracture of the teeth or careless use of dental instruments, should be treated by the application of diluted tincture of calendula to the exposed surface, and the pulp then capped by a gold or platinum concave cap filled with the oxid of zinc, carbolic acid, and oil of cloves paste, and a permanent filling in the cavity. Cases of accidental exposure of healthy pulps admit of immediate treatment, as a general rule, without unfavorable results.

In cases of long exposure it has been recommended to wash out the cavity with a warm solution of salt and water, for its sedative effect, or of carbonate of soda; then to apply creasote on a pledget of cotton, over which the paste of oxid of zinc and a temporary filling of Hill's stopping are placed, to remain for one or two days; then to remove the temporary filling and, if no pain has been experienced, to permanently fill the cavity.

Where it is desirable to cap the pulps of the temporary teeth, a convex cap of platinum, the concavity of which is filled with the solu-

tion of gutta-percha and chloroform, may be applied in such a manner as to avoid pressure, and a Hill's stopping filling inserted over the cap.

The treatment just described refers to pulps free from disease, the condition being primary irritation from exposure and not inflammation from long-continued irritation. In the great majority of the latter cases attempts at preservation prove failures, and when persisted in may prevent any successful subsequent treatment following the extirpation of the pulp. Hence it is necessary to accurately determine the condition of the pulp, when exposed, by a careful examination before treatment is commenced. When the patient possesses a healthy constitution and correct local conditions are present, efforts for the preservation of pulps in more or less unhealthy conditions may be instituted. For example, if effusion of serum or lymph is present the tincture of aconite should be applied to the pulp and also to the gum about the neck and root of the tooth, after which the application of pure carbolic acid to the exposed surface of the pulp, to produce coagulation, is indicated. If such treatment arrests the exudation, which may be determined by drying the parts, then the treatment for a simple exposure of the pulp may be at once instituted, or oxid of zinc made into a paste with water may be applied and the cavity in the crown of the tooth filled with a temporary material. Should the exudation continue, the oxid of zinc, carbolic acid, and oil of cloves paste may be applied to the exposed surface of the pulp, but a loosely introduced pellet of cotton saturated with sandarac should be substituted for the temporary filling, so that the fluids of the mouth may be excluded, but the cavity should not be closed so tightly as to cause trouble by the retention and accumulation of the effusion. When the vessels of the pulp are engorged, depletion by means of an incision, after the application of equal parts of oil of cloves and chloroform, may be made and the pulp be capped by the paste before referred to, over which a pellet of cotton saturated with sandarac may be placed. Such a dressing is allowed to remain for several days, when, if everything is favorable, the permanent capping of the pulp may be made. For purulent discharges from the pulp, after the removal of the irritation, the treatment consists in the application of a mild escharotic in the form of a solution of chlorid of zinc, grs. xxx, water ℥j, for several minutes, after which repeated injections of tepid water should be made and the cavity exposed to the saliva to free the eschar from the chlorid of zinc. The subsequent treatment is the same as that described for effusions of serum and lymph. After capping an exposed pulp the case should be carefully watched, and if there is undue sensitiveness to cold, which is usually the indication of further trouble, the gum about the affected tooth should be bathed with a solution composed

of tincture of aconite, ʒij, and chloroform, ʒj. Several applications may be required, although frequently but one is necessary. Another application for the same condition, or in case the former one is not effective, consists of tincture of iodin, fʒij; tincture of aconite, fʒj, and chloroform, fʒj.

CHAPTER IV.

FILLING PULP CHAMBERS AND CANALS OF TEETH.

THIS operation has now become very common, and is practiced by the most skillful dentists in America and Europe.

Drs. Maynard and Baker were the first to show that most of the morbid phenomena resulting from the presence of a tooth in the mouth after the destruction of the pulp arose from the irritation produced by the matter contained in the pulp chamber and canal of the root. To prevent their occurrence, therefore, they proposed filling both chamber and canal in such a manner as completely to exclude everything else. The accumulation of purulent matter being prevented here, its secretion at the extremity of the root will, in a majority of cases, either cease altogether or go on faster than it is reabsorbed, as has been shown by repeated experiments. Thus it would seem that the amount of vitality which a tooth derives from the investing membrane is sufficient, ordinarily, to prevent it from exerting any apparent morbid action upon the surrounding parts.

Although it is desirable that the operation should be performed before any diseased action has been set up at the extremity of the root, much advantage may also be derived from it, even after alveolar abscess has actually occurred, as great benefit often results from cleansing, disinfecting, and filling the root-canals of teeth which are affected with abscess.

The application of disinfectant and antiseptic agents to the inner walls of the sac, introduced through the canal in the root previously to filling, is one of the most certain means of cure. All root-canals do not require to be drilled out or enlarged, and filled solidly to the apex in order to ensure comfort to the tooth; yet all canals should be sterilized that, owing to their small size and tortuous direction, cannot be filled. Very small and abnormally situated canals can have their openings into the pulp-chamber exposed by flooding this chamber with absolute alcohol and drying it with hot-air. Alcohol will also absorb the moisture from the pulp-tissue remaining in the canals and facili-

tate its removal. When the openings of the canals have been located, their orifices should be reamed out to such a degree as will indicate the size and direction of the canals. A small, stiff broach should then be employed to explore each canal as far as possible, and when the broach cannot pass beyond a certain point, it may be regarded as conclusive that the caliber of the canal thus explored is so small that no trouble will result from failure to proceed further. An antiseptic should then be pumped well into the canal by flooding the pulp-chamber and forcing on the medicine a piece of soft vulcanite or cotton.

A favorite method of filling root-canals is to first introduce chloro-percha, and after thus lubricating the canal, to force into it, with gentle but constant pressure, a cone of gutta-percha, which the lubricant will soften and thus permit of its easy introduction into and adaptation to the canal. Some prefer a solution of eucalyptol and gutta-percha to the chlora-percha, on account of the eucalyptol being less irritating than the chloroform in the chloro-percha.

Treatment Preparatory to Filling the Canals of Teeth.—The following is a method of treatment, preparatory to filling root-canals, which has for some time been pursued: Carefully remove all disorganized pulp and decomposed dentine; also all softened dentine. Then syringe out all loose particles of the debris with tepid water, and dry the canal to the apex of the root with floss silk, being careful to leave an end projecting, so as to permit its easy removal. Several such pieces being used, a shorter piece is then saturated with pure wood creasote or carbolic acid, and passed to the end of the canal, leaving a slight projecting piece in the crown-cavity, so that it may be seized with pliers when it is to be removed.

Then introduce into the crown cavity a temporary filling of Hill's stopping, gutta-percha, or the zinc preparations. In some cases where the effusion is considerable, and its retention causes discomfort, the temporary filling should consist of cotton, loosely introduced, so that it may be readily removed by the patient if necessary. In twenty-four hours the canal is examined, and the antiseptic agent renewed if necessary. When not the slightest odor of purulent secretion is perceptible, then apply on the floss silk carbolic acid mixed with a little chloroform, replace the filling, and wait for several days.

If at the end of this time there is no trace of diseased action, fill the canal; then wait a few days until all chance of irritation from the pressure used in the operation has passed away, and then complete the filling. But not unfrequently it is necessary to repeat this course of treatment several times.

In some cases it may be prudent to insert a filling of "Hill's stopping" for several months, especially when there is the slightest

doubt of the arrest of the disease; for the gold once introduced into the canal, it is exceedingly tedious and difficult to remove it. Disease on the *outside* of the extremity of the root may be controlled by creasote, carbolic acid, or other disinfectants and antiseptics, applied through the fistulous or an artificial opening in the alveolus. (See Alveolar Abscess.)

Chlorid of zinc may be used instead of creasote when the smell of the latter is particularly repulsive to the patient; also, a combination of carbolic acid or creasote and iodin, as Dr. Leech's formula, which is composed of iodin (crystals), ʒj; carbolic acid (crystals), ʒj; alcohol, fʒij, applied on a pledget of cotton or on floss silk; or a saturated solution of iodoform and ether; or eucalyptus combined with iodoform, as Dr. Parmele's formula, which is composed of eucalyptus oil, ʒj; iodoform, gr. x; water, ℥j; or Dr. Black's mixture, composed of carbolic acid one part, oil of cassia two parts, and oil of gaultheria three parts, all of which are excellent antiseptics. Any trace of the living pulp should be treated with some devitalizing agent, which may be introduced upon floss silk before commencing the antiseptic treatment.

The following are the methods of treating pulpless teeth pursued by Prof. Gorgas and others:—

The temporary or deciduous teeth should be retained for their full natural term, and if from any cause their pulps become diseased before such a period, the first thing to be done is to open the pulp chamber. Should such a tooth be painful to the touch, it should not be further operated on until the soreness has disappeared. Then the cavity of decay should be thoroughly cleansed, the dead pulp removed, and a pellet of cotton, saturated with such a solution as the following: Carbolic acid (5 per cent. solution) ℥j, cinnamon or peppermint water gtt. lx, placed in the pulp-chamber and covered with a pellet of dry cotton or soft rubber (such as a piece of rubber-dam). Pressure should then be made upon the cotton or rubber with a blunt instrument until the fluid appears at the fistulous opening, if one exists. The cotton or rubber should then be removed, the crown-cavity and root-canals dried, then by means of a small pellet of cotton wound on a broach, a solution of gutta-percha in chloroform, of the consistence of cream, should be forced into the root-canals, after which the canals should be filled with gutta-percha cones, which may be easily introduced owing to the solvent action of the chloroform already in the canals.

Pulpless deciduous teeth without fistulous openings are treated in the same manner as permanent teeth with blind abscesses.

In cases of the permanent teeth where it is necessary to devitalize the pulp, the rubber-dam should first be adjusted, the carious cavity

freely opened, and all loose matter and softened dentine removed, so that the pulp is freely exposed. A small pellet of cotton is then dipped in pure wood creasote, and $\frac{1}{40}$ or $\frac{1}{50}$ of a grain of the oxid of arsenic taken up on it and placed directly in contact with the exposed point of the pulp, and the crown-cavity carefully sealed in such a manner by a temporary filling as not to cause any pressure on the pulp. This preparation of arsenic should be permitted to remain for 24 hours, when it should be removed and the cavity carefully washed out. After the removal of the devitalized pulp, access to which is made by freely opening the root-canals, the drills employed for this purpose being frequently dipped into eugenol, or a 5 per cent. solution of carbolic acid, or other disinfectants and antiseptics, such as oil of cassia and wintergreen, or a solution of bichlorid of mercury—$\frac{1}{500}$ or $\frac{1}{1000}$—or peroxid of hydrogen, or peroxid of sodium. The use of sulphuric acid is also recommended for opening the pulp-canals (page 559). The root-canals should be thoroughly disinfected by any of the agents just mentioned and permanently filled with the gutta-percha cones or the zinc filling materials.

For the treatment of pulpless teeth affected with blind abscesses, the rubber-dam should first be adjusted, the main cavity of decay excavated, and all softened dentine removed. The pulp-chamber should be opened thoroughly and well syringed with tepid water. The root-canals should then be opened and carefully syringed with an antiseptic solution, then thoroughly dried and injected with peroxid of hydrogen until all bubbling ceases; peroxid of sodium (50 per cent. solution) may also be injected into the root-canals and into the apical space, or they may be bathed with eugenol, or with oil of cassia, carbolic acid, and wintergreen, or with oil of cassia and guaiacol, or carbolic acid (5 per cent. solution), or pure wood creasote, when the crown-cavity is loosely filled with dry cotton. After three days this treatment should be repeated, and continued at the same intervals until it is quite evident that the discharge of pus has ceased. When such is the case the root-canals should be tightly packed or well saturated with one of the disinfecting combinations before referred to, and the crown cavity filled with a temporary filling material, and the tooth permitted to remain at rest for four or five days. After this time, if no soreness is apparent on percussion or pressure, or any evidence of pus is apparent on removing the temporary filling, the canals should be thoroughly dried and permanently filled with gutta-percha or other root-canal filling material. The vapor of crystals of iodin forced into the apical space with a hot-air syringe constructed for such a purpose has also given satisfactory results in cases of blind abscess, as well as those with fistulous openings.

Dr. C. N. Johnson's method of treating pulpless teeth with no fistulous openings is as follows:—

The rubber-dam should be applied before any drilling is attempted, and an antiseptic (such as carbolic acid one part, oil of cassia two parts, and oil of gaultheria three parts) placed near at hand for immediate use the moment the pulp-chamber is penetrated. This antiseptic should be non-irritating and non-effervescing, in order that no septic matter in the canal be forced into the apical space. As soon as the chamber is reached by the drill, it should at once be flooded with the antiseptic, care being taken not to cause any pressure upon the contents of the canal. After a little time a bit of absorbent cotton or bibulous paper may be lightly applied to the opening to absorb enough of the antiseptic to admit of drilling to enlarge the opening, and when this is done the chamber may repeatedly be flooded, and the contents absorbed as before, till the greater part of the putrescent matter has been removed from the chamber and greater portion of the canals without causing disturbance at the apical foramen. When this process has been carried to the limit of safety, the cavity is flooded with absolute alcohol for its dehydrating effect, and this evaporated to dryness. The dryer the canals the less chance there is for micro-organic life to exist, and when an antiseptic is applied the greater will be the amount taken up by the tubuli. The crown of the tooth, however, must not be heated too hot in the process of drying the root, nor should it be kept dry too long for fear of injury through the checking of the tooth-structure. When dryness of the canals is obtained, they should once more be flooded with an antiseptic, this time to remain sealed in the cavity until the next sitting. The canals are left thus filled, but no cotton is forced into them at this time. A small pledget of cotton may be placed loosely in the chamber, and the opening closed with gutta-percha. The case may then be dismissed for one week, with instructions to return sooner in case of trouble. If in any doubt, the patient should be seen in 24 or 48 hours, and the dressing changed. At the end of the week, if no symptoms of irritation have been felt, and if the canals show no signs of putrescent matter on the removal of the dressing, the roots may be filled, first, however, washing them out with alcohol, drying them, flooding with the antiseptic, and finally drying. In case, however, after the first treatment the dressing should show signs of a blind abscess in the apical space, the treatment should be continued till all weeping of pus stops and the abscess heals.

Management of Pulpless Teeth with Fistulous Opening.—First, the soft decalcified dentine should be cleansed from the cavity and the pulp-chamber thoroughly opened, the putrescent contents of the canals removed as thoroughly as possible, and to accomplish this the

chamber and canals should be flooded with an antiseptic, and this absorbed with cotton or bibulous paper. When the canals are cleaned the abscess should be injected with the antiseptic through the canal, and the process kept up, if possible, till the medicine appears at the fistulous opening on the gum. This may be done by packing the canal tightly with cotton saturated with the medicine, and then forcing down upon it a mass of soft rubber such as is used for packing plates of dentures. When the medicine appears at the fistulous opening, if the case is one of recent occurrence, the cavity may at once be sealed—after replacing the cotton in the canal with freshly saturated cotton—and the patient dismissed for one week. If the case is one of long standing, where the dentine of the root is much infected, it is best after the injection to flood the canal with alcohol and evaporate to dryness before applying the antiseptic and sealing the cavity. This insures a more thorough saturation of the tubuli with the antiseptic, and the tooth will return to a better condition than if the drying had been omitted. When the patient returns, and the fistula is found perfectly closed, the root may be filled at this sitting, the same process being followed prior to filling as that advised in the case of roots with-

FIG. 509.

out fistulous openings. If the patient returns with the fistula still discharging, carbolic acid (95 per cent. solution) is injected till it appears at the fistulous opening. The canal is then packed with cotton saturated with carbolic acid, the cavity sealed, and the patient dismissed. If there has been much discharge with a free opening, pyrozone (3 per cent. solution) may be injected prior to the use of carbolic acid. Seal such a case for a week, and repeat the treatment if the fistula is found open at the end of that time. In chronic cases, where a third treatment has been found necessary, the dressing in the canal should not be disturbed for a month. The operator may see the patient in the meantime, and if he deems it necessary may treat the fistula through the opening, but in very many of these cases no treatment at all is preferable to any treatment.

The immediate filling of the root-canal in such cases has also been recommended. (See Low's Method, page 561.)

Fig. 509 represents iridio-platinum nerve broaches for extracting dead pulps of teeth and for introducing into the pulp-canal medicinal agents in the treatment of diseased teeth. They do not corrode when

exposed to moisture, acids, iodin, etc., and can be cleansed perfectly by heating to redness in the flame of a spirit lamp.

Fig. 510 represents a set of Dr. B. F. Arrington's devitalized nerve extractors and canal pluggers, of drawn and spring temper.

Fig. 512 represents Dr. Donaldson's spring-tempered nerve-bristles and pulp-canal cleansers.

Fig. 513 represents Dr. Walker's nerve-canal drills.

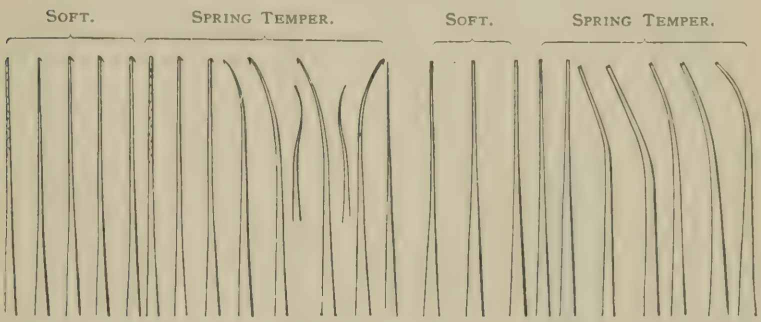


FIG. 510.

Filling Pulp Chambers and Canals of Teeth.—For filling pulp canals very nice instruments may be made from piano wire filed to any desired size and fitted into suitable handles. This wire is very tough and elastic. The gold used for filling pulp canals should be non-cohesive and folded into a very light ribbon, and this cut into square pieces, which should be placed upon a piece of folded chamois skin and

FIG. 511.

carried to the pulp canal by means of the nerve-canal plugger point. Piece after piece of the gold is carefully introduced to the apex or upper extremity of the root until the entire canal is filled. Strips of heavy gold foil conveyed to the apex of the canal in a similar manner, or by mallet force, are also employed for filling root canals. Malleting the gold into the canals is also preferred by many to pressure with the

hand, as percussion causes no deflection of the instrument such as may occur under pressure with delicate canal pluggers. The cavity in the crown is then filled in the usual manner.

Fig. 511 represents a set of nerve instruments contrived by Dr. Corydon Palmer for entering and enlarging the canals in the roots of the teeth.

Fig. 514 represents Dr. Hunter's set of pulp-canal pluggers, some of which are of drawn and others of spring temper.

After the cavity of decay in the crown has been properly prepared by means of the instruments represented in Fig. 512, the pulp chamber can be excavated and so shaped as to assist in the retention of the gold. Some operators drill out these canals and thus give them the same diameter from their orifice at the pulp chamber to the apex of the root, but this is considered by many to be an unnecessary as well as dangerous operation, as the instrument may pass through the side of the root, particularly where the root happens to be curved. Reaming out and enlarging the orifice of the canal may be sufficient in the majority of cases.

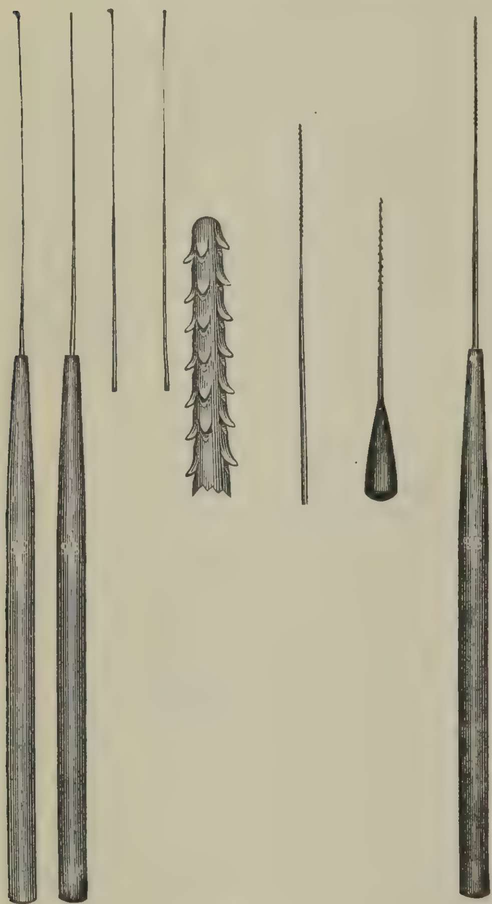


Fig. 512.

Fig. 513.

Others are satisfied with cleansing them perfectly of all debris and decomposed dentine, and thoroughly disinfecting them and rendering

FIG. 514.

the contents of the tubuli aseptic. Whichever method is pursued, care is necessary that the instrument is not passed beyond the foramen, which is more liable to occur in the case of young patients, when the teeth are not fully developed, than afterward; for in adult teeth there is generally such a decided contraction of the root canal near the apex as to arrest the progress of the instrument.

Figs. 515 and 516 represent sets of nerve-canal drills and reamers, devised for the enlargement of the canals prior to the filling of the same, and also for pivoting.

For facility of treating and filling, free access, however, should be had into root-canals by means of the instruments referred to. Recently the use of a 40 or 50 per cent. aqueous solution of sulphuric acid has been employed for opening

FIG. 515.

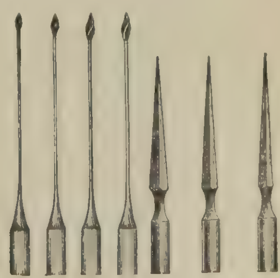


FIG. 516.

root-canals. This process is described as follows by Dr. J. R. Callahan: "Adjust the rubber-dam, open the pulp-chamber thoroughly,

twist a little cotton on the end of a broach, bend the broach to a right angle, so that it will reach well down into the cavity; place the broach in a suitable handle, and by means of broach and cotton place upon the dead pulp a drop or two of the sulphuric acid solution, which, by a process of dehydration, will cause the pulp to shrink and toughen, when it can be easily removed. By the broach and cotton, a drop of the solution is placed over the entrance to each canal, then with a pumping motion enter the canal slowly and carefully; the acid will destroy all septic matter and enlarge the diameter of the canals. By means of a syringe the root canals are then filled with a saturated solution of bicarbonate of soda, which will neutralize the acid and liberate carbonic acid gas in such quantities that the effervescence will carry all the broken-up tooth- and pulp-substances out of both the canal and tooth, leaving a deposit of bicarbonate of soda, which can be removed by a little sterilized water, alcohol, or peroxid of hydrogen. The roots can then be filled if no inflammatory symptoms are present."

Besides the method of filling the roots described above, there are several others, one of which consists in rolling strips or folds of gold on a fine broach in such a manner as to form cone-shaped cylinders, somewhat longer than the canal is deep, of different sizes and density. The soft rolls are first introduced on a smooth broach, or, if the canal is large and easily approached, by means of the pliers, and carried up as near to the apex of the root as is possible, each one being condensed as it is introduced. Successive cylinders are introduced in this manner and condensed until the canal is filled, the last ones, which complete the filling, being larger, of heavier gold, and more densely rolled. Pure gold or platinum wire is sometimes employed for filling these canals, so shaped as to correspond in size and taper with the cavity. These wires should be coated with gutta-percha or oxyphosphate of zinc before introducing them.

It sometimes happens that the canals in the buccal roots of the superior molars are so small as to preclude the introduction even of a small-sized bristle. In cases of this kind it is impossible to fill them, and fortunately, from their small size, they cannot serve as reservoirs for the accumulation of morbid matter. Such canals, however, should be thoroughly disinfected before the larger ones are filled. The canal in the palatine root is always much larger than in either of the buccal roots, and in a majority of the cases is filled with comparative ease. Although gold and tin have long been used for filling root canals, yet some non-metallic substances have answered well when employed for this purpose, such as cones of gutta-percha, chloro-percha, gutta-percha and eucalyptol, Hill's stopping, and the zinc filling materials. When

cones of gutta-percha are used for filling pulp-canals one end of the cone is dipped in chloroform, which softens it and facilitates its introduction and adaptation to the canal. Gold may be employed for filling the space of one-third of the canal from the apex, and the remaining portion may be filled with gutta-percha or oxyphosphate of zinc. Amalgam has also been employed for filling root-canals. An instrument represented by Fig. 517 is the invention of Dr. Geo. Evans for drying root canals preparatory to filling them. The oval mass of copper is heated in the flame of the lamp to a dull red, and the heat passes rapidly along the silver probe, which is inserted as far up the canal as possible. The effect is to evaporate the moisture and gases and carbonize any organic material in the canal and tubuli. For bleaching teeth which have become discolored from loss of vitality, the reader is referred to the chapter on that subject.

FIG. 517.

In the treatment of the canals of devitalized teeth, if there is a secretion of liquid (protoplasm) through the foramen into the pulp canal, bibulous paper or absorbent cotton may be employed for drying the canal, when chlorid of zinc in a deliquesced form should be introduced on cotton wound about a broach, which will coagulate the fluid emanating from the elements of the tissues about the apex of the roots, and the canal can at once be permanently filled. A putrescent pulp remaining in the root canals gives rise to the formation of sulphureted and phosphoreted hydrogen gas from the disintegrating tissue, which, with the particles of such tissue and the foreign matter forced through the foramen, causes irritation of the tissues surrounding the apex of the root. The secretion of pus will continue as long as the putrescent matter remains in the canal and the mephitic gas evolves from it through the apical foramen, and relief is experienced only when the suppurating surface is destroyed and a normal action brought about by removal of the irritating matter and the action of an escharotic or disinfectant, such as carbolic acid or creasote, iodoform, eucalyptus, peroxid of hydrogen, etc., assisted by injections of warm water as a cleansing process.

The method of "immediate root-filling" is described by Dr. Frank W. Low as follows:—

"The instruments best adapted for general use,

especially in the deeper portions of the pulp canals, are Donaldson's spring-tempered pulp-canal cleansers. First, because, if they penetrate a root in which is present a sloughing and partly disorganized filament of the pulp, they seem to cause less pain than barbed broaches, and are more likely to so engage the fibre as to bring it away entire. Second, in the absence of any sensitive filaments the debris is removed rapidly, engaging itself in the screw threads of the instrument its entire length, from which it can be readily removed when withdrawn by brushing with an ordinary tooth-brush. Third, because if it is found, when screwed into the canal, that it will not *strip* out—thus bringing its load—it can be safely and easily disengaged by turning to the left, as you would remove any other screw-threaded instrument. Fourth, because the worn-out instruments are of such fine temper that they can be ground on the lathe corundum wheel into four or five-sided broaches, and as such can be utilized to wrap minute shreds of absorbent cotton upon for the final drying process before the gutta-percha cones are introduced. Several of these can be wound, even by an inexperienced assistant, and thus be ready at once for rapid successive introduction just preceding that of the cones.

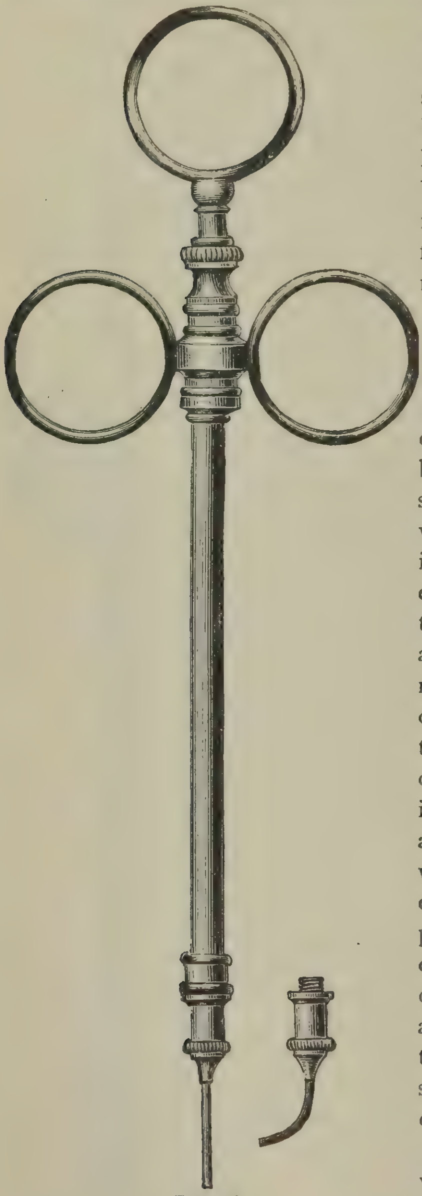


FIG. 518.

"The penetration of canals will be accelerated by frequent injection of peroxid of hydrogen, because of the expulsion of their contents, incident to the effer-

vescence of this compound, as well as its chemical combination with and consequent softening of the products of infection present.

"When the instruments have at length penetrated the apex of the root—of which fact you may safely trust the patient to make you aware —it will often be found upon injecting the peroxid solution once more that effervescence (which perhaps just before had nearly or quite ceased) will again manifest the presence of septic matter; this, however, is caused by the pus so often confined in the 'apical space,' and any further penetration of the broach is contraindicated. It is not sufficient merely to inject in order to obtain the full benefit of the peroxid in this new territory of infection, but the plunger of the syringe should be worked with a rapid churning motion for several seconds, while the nozzle of the instrument remains as deeply fixed as possible in the pulp canal under treatment, for by this reciprocating motion of the plunger the fluid is forced beyond the apex of the root and into the infected territory, and thoroughly mixed with any pus which may then be present.

"An instrument well adapted for the purpose of thus injecting the peroxid of hydrogen is the Lewis abscess syringe (Fig. 518). The advantages to be derived from its use are that it can be operated with one hand and the pumping or churning motion above mentioned be easily accomplished. The capacity of the syringe is so small that the injecting process is prevented from becoming a sloppy one, while at the same time the fit of the plunger is so perfect that the injection is accomplished with considerable force.

"When effervescence again ceases—which will be indicated if, upon removal with cotton or spunk of all the 'lather' previously made, it is found that further injection produces only such bubbles as may be expected from the confinement of particles of air in any liquid—the canal should be wiped out and an injection of the $\frac{1}{1000}$ bichlorid of mercury solution substituted. It is just possible that the use of the bichlorid solution might be dispensed with; but it is the most powerful known germicide, and besides it is just sufficiently irritant to cause the inner walls of the abscess—if one be present—when collapsed, to become obliterated by adhesion.

"To facilitate this collapse of the walls of the pus sac, the syringe again comes into use as an aspirator. The use of the dry hot air current is next indicated, and last of all the little broaches wound with cotton shreds. Several of these latter should be used, even though the first one withdrawn appears to be dry, because they are the most perfect exhaust plungers after all. Following their use, the canals should be quickly sealed with gutta-percha cones dipped in a thin chloropercha solution to facilitate their deep penetration into the canal and

at once to varnish them tight to its walls. A moment's wait—which usually is gratefully accepted both by operator and patient—is now advisable in order that the chloroform of the chlora-percha, which, as the cone descends into the cavity of the canal, will be found to have regurgitated, may have an opportunity to evaporate. After wiping this off with spunk or cotton, the cone will be found very soon to be dry,

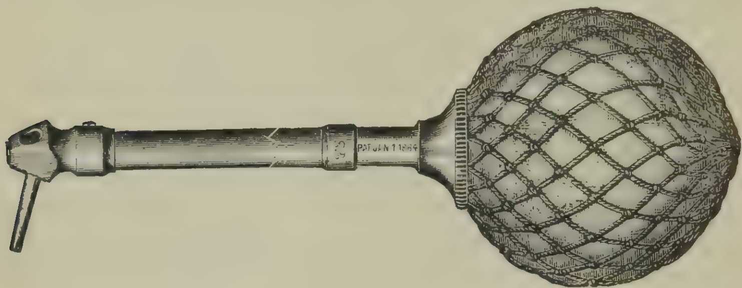


FIG. 519.

and then it can be condensed a trifle, after which, if the material to be used be other than gold, the crown filling can safely be made at once.

"If gold is to be the material used, the operation had better be deferred for a few days, lest the impact of the plugger should cause acute inflammation of the irritable peridental membrane."

Another convenient syringe is the Laskey (Fig. 519), from which an obstruction of the discharge-pipe can be readily removed.

CHAPTER V.

EXTRACTION OF TEETH.

THERE are few operations in surgery that excite stronger feelings of dread, and to which most persons submit with more reluctance, than the extraction of a tooth. Many endure the torture of toothache for weeks, and even months, rather than undergo the operation; and, indeed, when we take into consideration the frequent accidents occurring in its performance by awkward and unskillful individuals, it is not surprising that it should be approached with apprehension. But when performed by a skillful hand and with a suitable instrument, the operation is always safe, and in a large majority of the cases may be effected with ease.

Numerous cases of serious injuries show the impropriety and danger

of intrusting this operation to individuals possessing neither knowledge of its principles nor skill in its performance. Injuries occasioned by the operations of such persons have frequently come under the immediate observation of the author, with whom it has always been a matter of surprise that an operation to which such universal repugnance is felt should ever be confided to them.

The removal of a wrong tooth, or of two or three instead of one, are such common occurrences that it were well if the precautions given by the illustrious Ambrose Paré were more generally observed. So fearful was he of injuring the adjacent teeth, that he always isolated the tooth to be extracted with a file before he attempted its removal. He regarded it as of the greatest importance that a person who extracted teeth should be expert in the use of his "tooth mullets; for unless he knows readily and cunningly how to use them, he can scarcely so carry himself but that he will not force out three teeth at once." Although great improvements have been made since his time in the construction of extraction instruments, yet even now the accidents to which he alluded are of frequent occurrence.

It is surprising that an operation so frequently called for should receive so little attention from medical practitioners, by whom, though not strictly belonging to their province, it must frequently be performed. This neglect can only be accounted for by the too general prevalence of the idea that little or no surgical skill is necessary to its performance. But every physician residing in the country, or where the services of a skillful dentist cannot always be commanded, should provide himself with the proper instruments, and make himself acquainted with the manner of performing this operation.

INDICATIONS FOR THE EXTRACTION OF TEETH.

With regard to the indications that determine the propriety of extraction, the author does not deem it necessary to say much in this place, as they are fully pointed out in other parts of the work. It may be well, however, to briefly mention, in this connection, a few of the circumstances which call for the operation.

Beginning with the teeth of first dentition, it will be sufficient to state that when a tooth of replacement is about to emerge from the gums, or has actually made its appearance, either before or behind the corresponding deciduous tooth, the latter should at once be removed; and when the aperture formed by the loss of this is so narrow as to prevent the former from acquiring its proper position, it may sometimes be necessary to extract an adjoining temporary tooth. For more explicit directions upon this subject, the reader is referred to the chapter on Second Dentition. Alveolar abscess, necrosis of the walls of the alve-

olus, and pain in a temporary tooth which cannot be cured by any of the usual remedies, may be regarded as indications which call for the operation.

The principal conditions which should determine the extraction of a permanent tooth may be enumerated in the following order:—

First, when a molar, from the loss of its antagonizing tooth, or from other causes, has become partially displaced, or is a source of constant irritation to the surrounding parts.

Second, a constant discharge of fetid matter from the pulp cavity through a carious opening in the crown. There may, however, be circumstances which would justify a practitioner in permitting or even advising the retention of such a tooth, as, for example, when the discharge of fetid matter is not very considerable; also, where the tooth is situated in the anterior part of the mouth, and cannot be securely replaced with an artificial substitute. The secretion of fetid matter may in some cases, by judicious treatment, be arrested, the tooth preserved for many years by filling, and so the morbid influence it would otherwise exert upon the surrounding parts may be counteracted. A front tooth should not be sacrificed unless called for by some very urgent necessity; neither should an upper incisor nor cuspid be permitted to remain in the mouth if it exerts a manifestly morbid action upon the surrounding parts, for in this case the consequences resulting from its retention in the mouth may be worse than the loss of the tooth.

Third, a tooth which is the cause of an incurable alveolar abscess should not be permitted to remain; but if it be an incisor or cuspid, and the discharge of matter through the gum is small, occurring only at long intervals, and especially if the organ cannot be securely replaced with an artificial substitute, it may be permitted to remain. An incurable abscess in the socket of a bicuspid or molar should always be considered as a sufficient indication for the removal of the tooth.

Fourth, irregularity in the arrangement of the teeth, arising from disproportion between the size of the teeth and the size of the alveolar arch, usually requires for its correction the extraction of some one or more teeth. But with regard to the teeth most proper to be removed the reader is referred to the chapter on Irregularity, where he will find full directions for the management of such cases.

Fifth, all dead teeth and roots of teeth which act as irritants, and teeth which have become so much loosened, from the destruction of their sockets, as to be a constant source of disease to the adjacent parts, or teeth otherwise diseased that are a cause of neuralgia of the face, disease of the maxillary sinus, dyspepsia, or any other local or constitutional disturbance, such teeth should, as a general rule, be extracted.

There are other indications which call for the extraction of teeth, but the foregoing are among the most common; they will be found sufficient in most instances to determine the propriety or impropriety of the operation. Cases are, however, continually presenting themselves to which no fixed rule would be found applicable, and where an experienced judgment alone can determine the practice proper to be pursued.

In conclusion, it is scarcely necessary to say that whenever a tooth can be restored to health it should always be done; but tampering with such as cannot be rendered healthy and useful, and which, by remaining in the mouth, exert a deleterious influence, not only upon

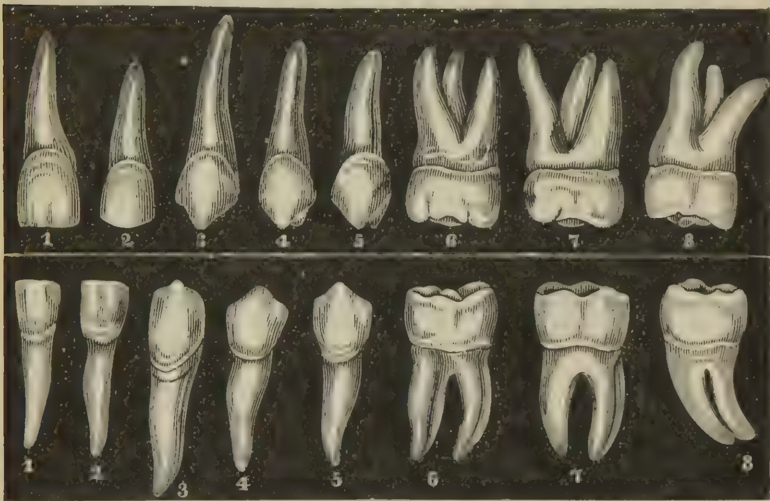


FIG. 520.

the adjacent parts, but also upon the general health, cannot be too strongly deprecated.

Fig. 520 represents the permanent teeth of the left side, a study of which will enable the student to form a correct idea concerning crowns and roots of the different classes of teeth.

INSTRUMENTS EMPLOYED IN THE OPERATION.

Different operators employ different instruments. For about fifty years the key of Garengeot was almost the only instrument used in the performance of the operation; but this has in a great measure been superseded by forceps, which, when properly constructed, are far preferable; yet as the key is still used by some, a brief description of it is here given.

Key Instrument.—"The common tooth-key," says Dr. Arnot, "may be regarded in the light of a wheel and axle, the hand of the operator acting on two spokes of the wheel to move it, while a tooth is fixed to the axle by the claw and is drawn out as the axle turns. The gum and alveolar process of the jaw form the support on which the axle rolls."

Different dentists have their keys differently constructed, but the principle upon which they all act is precisely the same. Some prefer the bent shaft (Fig. 521), others the straight. Some give a decided preference to the round fulcrum, others to the flat; and though the success of the operator depends greatly upon the perfection of the instrument, yet he may remove a tooth more expertly by means of a key with which he is familiar than by one to which he is unaccustomed, though its construction be even better. Fig. 521 represents a key with bent shaft and two hooks, one for molars and the other for bicuspids.

The principle of action of the key is, in fact, not unlike that of a nail drawer or tack puller, and may be adapted to a certain class of

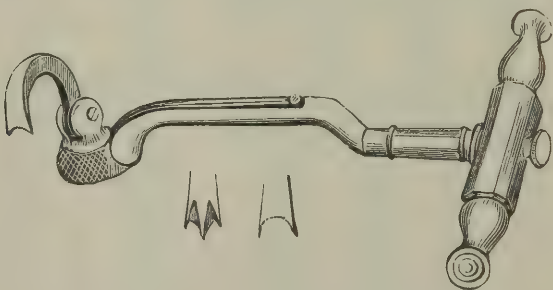


Fig. 521.

cases, namely, where one wall, either the inner or outer, is decayed below the alveolus, while the opposite one is still standing. The fulcrum, with a folded napkin or other soft substance interposed, is placed against the gum on the side of the tooth most decayed and the hook adjusted to the neck of the tooth on the opposite side. With the improved forms of forceps now in use, teeth can be extracted with greater facility, less pain to the patient, and also with less risk of fracture than is possible with the key instrument; hence, the latter is rarely employed at the present time.

Forceps.—Forceps were not very generally or extensively employed, except for the extraction of the front teeth, until about the year 1830; but the improvements made in their construction since that period are so great that their use has now, among dentists, superseded that of the key.*

* To Prof. Chapin A. Harris is due the credit of having devised the first improved set of forceps for the extraction of teeth, of which many of the later inventions are modifications.

In order that forceps may be used with ease, it is necessary they should be properly constructed. Every operator should possess a number of pairs (nine at least), each with a differently shaped beak adapted to the necks of the teeth to which they are respectively designed to be applied.

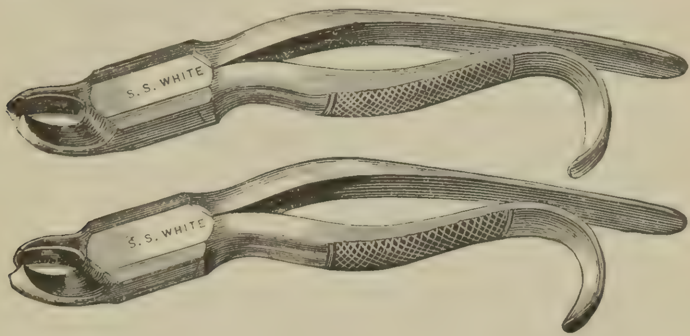


FIG. 522.

For the upper molars two (Fig. 522) are required, one for each side, curved just below the joint, so that the beak shall form an angle of twenty or twenty-five degrees with the handles, just enough to clear the lower teeth. The inner blade is grooved to fit the neck of the palatine root; the outer blade has two grooves, with a point in the

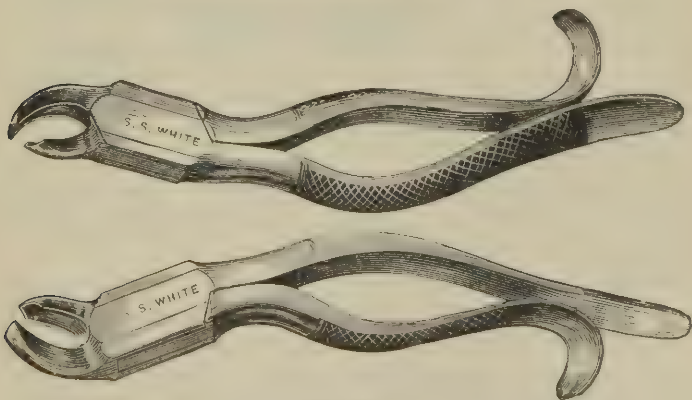


FIG. 523.

center to fit the depressions just below the bifurcation of the two buccal roots. Another valuable improvement consists in having one of the handles bent so as to form a hook. This passes round the operator's little finger, to prevent the hand from slipping.

Fig. 523 represents another form of superior molar forceps, right and

left, with a greater curvature in the handles than the C. A. Harris pattern, which some consider an improvement.

The handles of forceps should be wide and large enough to prevent them from springing under the grasp of the hand, to which they should be accurately fitted, and the ends of the straight handles should be thick and rounded to prevent injury to the palms of the hands. For the comfort of the fingers, the inner corners of the handles should also be rounded. Every dentist, therefore, in having forceps manufactured, should give special directions with regard to their shape and size. The beak should be bent no more than is absolutely necessary to prevent the handles from coming in contact with the teeth of the lower jaw; for in proportion to the degree of curvature will the muscular power of the operator be disadvantageously exerted.

Each blade of the beak of the lower molar forceps has two grooves, with a point in the center so situated that in grasping the tooth it comes between the two roots just at the bifurcation. An improvement made by Prof. C. A. Harris in 1833 consists in having the handles of the

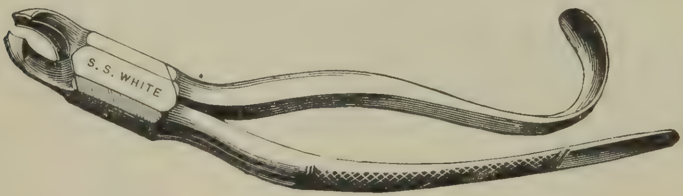


FIG. 524.

instrument so bent that it may be as readily applied to one side of the mouth as the other, while the operator occupies a position to the right and a little behind the patient. By this improvement the necessity for two pairs is superseded; it, moreover, enables him to control the head of the patient with his left arm and the lower jaw with his left hand, rendering the aid of an assistant wholly unnecessary.

The shape of the instrument as improved by the author is shown in Fig. 524. It is now used by many hundreds of operators, who prefer it to any other instrument they have ever employed. When applied to a tooth the handles turn toward the operator at an angle of about twenty-five or thirty degrees. Without this curvature in the handles the arm of the operator would often be thrown so far from his body as to prevent the proper control over the instrument. It is also important that the handles should be wide and accurately fitted to the hand. The inferior dentes sapientiæ can also, in the majority of cases, be removed with this form of forceps.

Fig. 525 represents Wolverton's inferior molar forceps for either

side, with longer points in the center of each blade of the beak, which answer a good purpose where the roots slightly diverge and admit the points within the bifurcation.

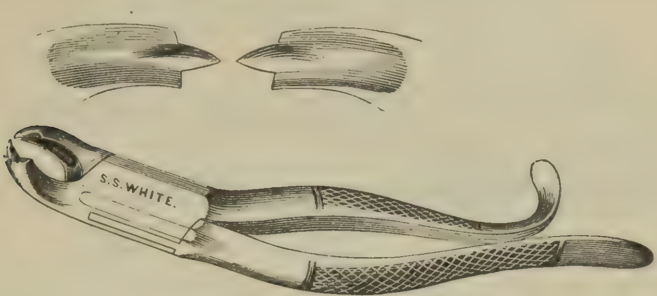


FIG. 525.

Fig. 526 represents inferior molar forceps for the right and left sides of the mouth, which some prefer to the single forceps on account of the position of the hand grasping the instrument.

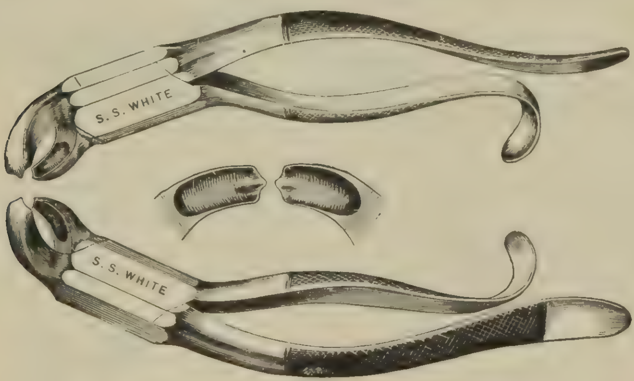


FIG. 526.

Fig. 527 represents a lower molar forceps with plain beaks, for use on either side, intended more especially, however, for the inferior third molars.

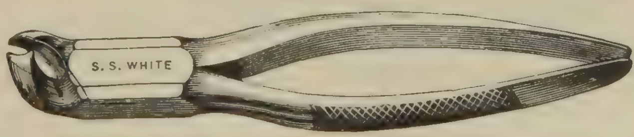


FIG. 527.

For the extraction of the upper incisors and cuspids one pair only may be used, although an instrument with the inner concave beak

somewhat narrower than the outer conforms more nearly to the shape of the necks of the superior cuspids, and is preferred by many for the removal of these teeth (Fig. 528). These should be straight, with grooved or crescent-shaped jaws accurately fitted to the necks of the teeth. The beaks should also be thin, so that they may be easily in-

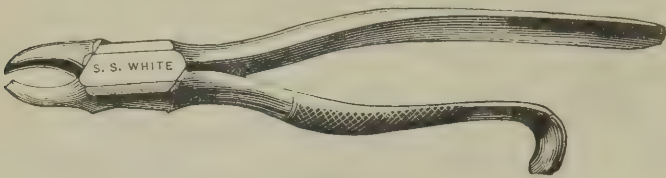


FIG. 528.

troduced under the gum, up to the edge of the alveolus. And, like the superior and inferior molar forceps, the handles should be large enough to prevent them from springing in the hand of the operator, with a hook formed at the end of one of them.

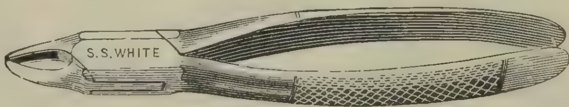


FIG. 529.

Owing to the difference in size between the superior central and lateral incisors, forceps with beaks much narrower than those of the common form of superior incisor forceps are frequently required for the extraction of the latter teeth. Fig. 529 represents an upper lateral incisor forceps with narrow beaks.

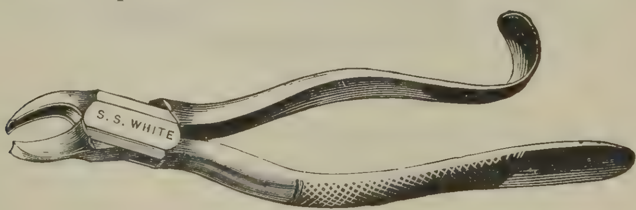


FIG. 530.

Fig. 530 represents another form of a superior cuspid and bicuspid forceps, in which the beaks curve more than those of the incisor forceps.

For the extraction of the lower incisors a pair of very narrow beaked forceps is necessary, to prevent interfering with the teeth adjoining the one to be removed. The beaks below the joint of the

instrument should be bent downward at an angle of about twenty-five degrees with the handles (Fig. 531). This is also a very valuable instrument for the extraction of the roots of teeth.

An instrument similarly shaped, but with the beaks much longer,

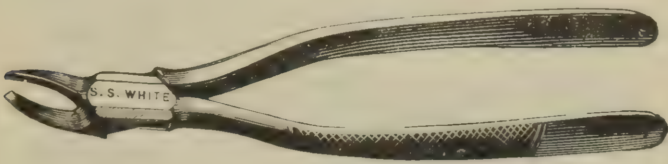


FIG. 531.

makes one of the most universally applicable instruments that can be devised (Fig. 532). The beaks should be made strong, but very narrow.

Fig. 533 represents an inferior incisor hawk-bill forceps, which is

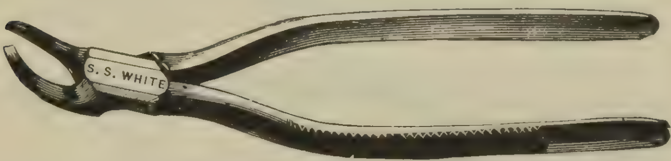


FIG. 532.

a very convenient instrument for the removal of these teeth. It is also used for the removal of the lower cuspids.

Forceps for the extraction of bicuspids should have their jaws so bent as to be easily adapted to these teeth; they should be narrow

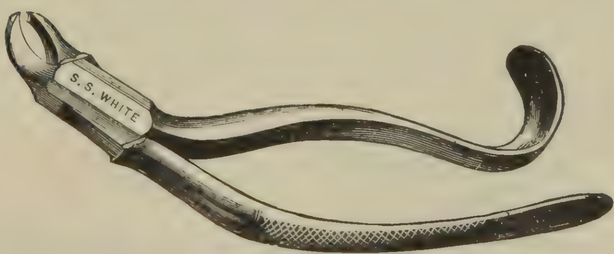


FIG. 533.

and have a deeper groove on the inside than those for the upper incisors and cuspids; like them, they should be thin, yet strong enough to sustain the pressure which it may be necessary to apply. One pair will answer for the right and left bicuspids of the upper jaw (Fig. 534).

For the removal of the cuspids and bicuspids of the lower jaw the hawk's-bill forceps (Fig. 533), with crescent-shaped beaks, is often employed; but the instruments represented in Figs. 535 and 536 are, we think, better suited to the extraction of these teeth, and can be

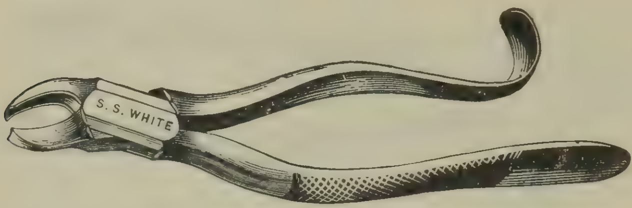


FIG. 534.

more conveniently applied. No separate instrument, therefore, is required for the removal of the inferior cuspids.

The dentes sapientiæ can, in many cases, be extracted with the universal bicuspid forceps, as shown in Fig. 535, which is half curved,

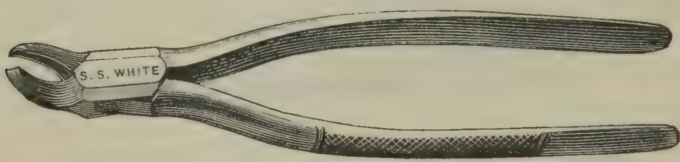


FIG. 535.

with two concave beaks. But there is another kind of forceps which may be more conveniently employed for the removal of the upper wisdom teeth. The beak of these is bent above the joint, forming nearly two right angles, as shown in Fig. 537. These forceps

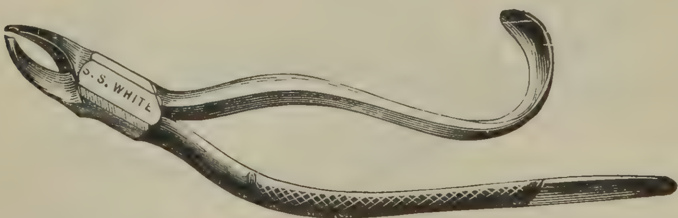


FIG. 536.

were, we believe, invented by Dr. Edward P. Church about the year 1830, and in those cases where the superior dentes sapientiæ are considerably shorter than the second molars, they can be successfully and advantageously employed; and, indeed, in many cases they

cannot be reached with any of the above-described extracting instruments. The handles of these, as of all other forceps, should be no

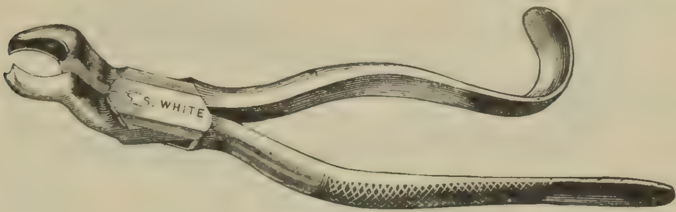


FIG. 537.

longer than is absolutely necessary for the accommodation of the hand of the operator.

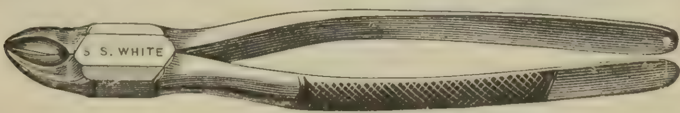


FIG. 538.

For the removal of the inferior dentes sapientiæ, the forceps represented in Fig. 524, Harris's pattern, or the ones represented in Figs.

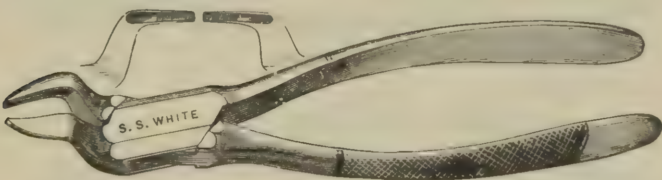


FIG. 539.

526 and 527 may be employed. Fig. 538 represents Physick's dentes sapientiæ for either side, which is used as an elevating forceps.

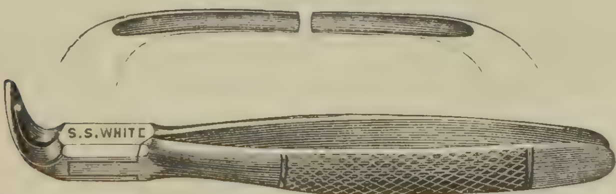


FIG. 540.

For the removal of the roots of the teeth the inferior incisor forceps represented in Figs. 531 and 532 are very useful; also the forms represented in Figs. 539 and 540.

Figs. 541, 542, 543, 544, and 555 represent Parmley's patterns of alveolar forceps for cutting through the alveolar process to the roots of the teeth.

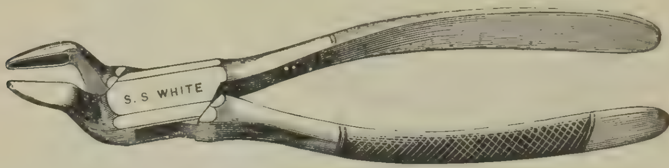


FIG. 541.

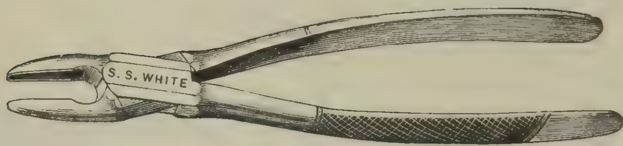


FIG. 542.

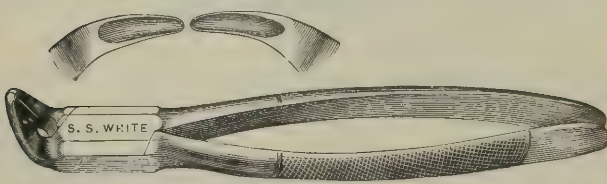


FIG. 543.

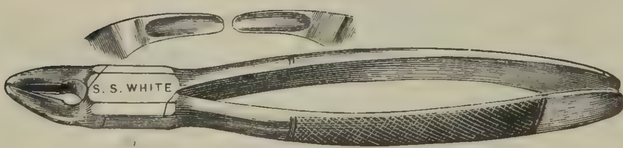


FIG. 544.

The following figures (545, 546, 547, 548, 549, 550, 551, 552, 553, 554) represent a set of ten forceps, called "Common Sense Forceps," which have recently been devised, and which present many useful features worthy of consideration :—

FIG. 545.—FOR UPPER CENTRAL INCISORS AND CUSPIDS, EITHER SIDE.

FIG. 546.—FOR UPPER LATERAL INCISORS, BICUSPIDS, AND ROOTS, EITHER SIDE.

FIG. 547.—FOR RIGHT UPPER MOLARS.

FIG. 548.—FOR LEFT UPPER MOLARS.

FIG. 549.—FOR UPPER THIRD MOLARS, EITHER SIDE.

FIG. 550.—FOR UPPER ROOTS AND SPICULÆ, EITHER SIDE.

FIG. 551.—FOR LOWER INCISORS AND SINGLE ROOTS, EITHER SIDE.

FIG. 552.—FOR LOWER CUSPIDS AND BICUSPIDS, EITHER SIDE.

FIG. 553.—FOR LOWER MOLARS, EITHER SIDE.

FIG. 554.—FOR LOWER THIRD MOLARS, EITHER SIDE.

Dr. W. Storer How writes of the "Common Sense Forceps" as follows: "There is scarcely any instrument used in dentistry that has called forth more ingenuity in devising various shapes than forceps. The object has been to provide a series of instruments of this class which will closely conform to the several classes of teeth, so that they may be removed with the least pain possible to the patient, and

the expenditure of only the necessary force by the operator. As a general rule, ten forceps will answer for a complete set, but for the

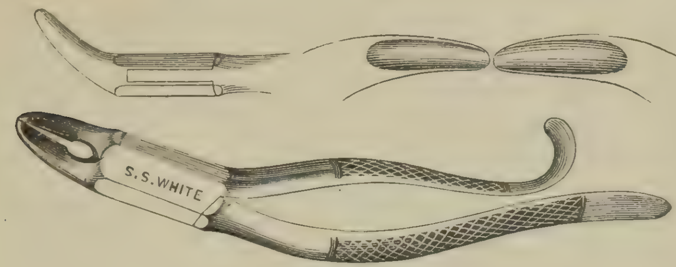


FIG. 555.

requirements of wide ranges of practice, supplemental forms of forceps will be desirable. Skill in the use of a moderate number of these

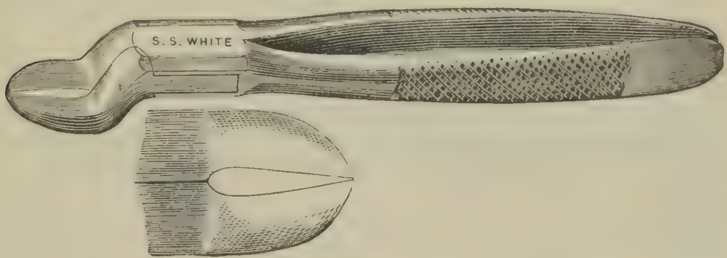


FIG. 556.—SUPERIOR.

instruments is preferable to crowding one's case with an unnecessary number."

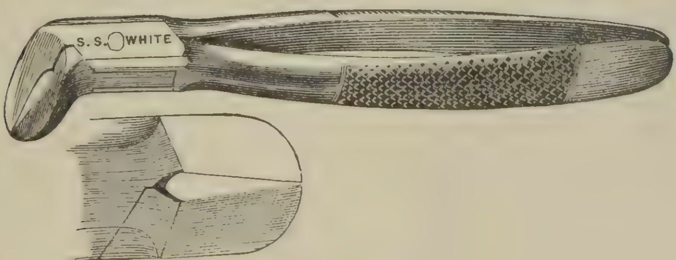
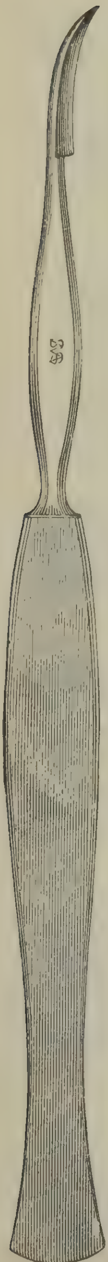


FIG. 557.—INFERIOR.

The form of forceps represented by Fig. 555 is very useful for the extraction of inferior cuspids and bicuspids, both right and left: also for the extraction of roots of inferior teeth.

Figs. 556 and 557 represent Stellwagen's superior and inferior for-



ceps for separating the diverging roots of molar teeth, and which may also be used as elevating forceps.

MANNER OF USING THE FORCEPS.

In describing the manner of using these instruments we shall commence with the extraction of the incisors of the upper jaw. These are generally more easily removed than any of the other teeth.

The use of the gum lancet should generally precede the application of either the forceps or the key. Many dentists object to the operation as unnecessarily inflicting double pain. Some have their forceps made with thin, sharp blades, so as to sever the gum on two sides in the act of pressing up the instrument. This practice may be admissible, perhaps necessary, in certain exceptional cases, as with children or nervous persons, whom the act of lancing might deter from permitting the operation to be completed. But we are fully satisfied that, as a rule, it is very objectionable, either in the use of the key or of the forceps. Owing to the great improvement in the form of the edges of the beaks of the forceps now manufactured, the use of the gum lancet is scarcely necessary, except in the case of teeth that stand alone, where lancing of the gum may prevent the laceration or tearing of the soft tissues, and also in the case of the wisdom teeth and roots of teeth imbedded in the gum.

Fig. 558.

Figs. 558 and 559 represent several forms of gum lancets.

Fig. 559 represents a convenient two-blade gum lancet with stop.

After separating the gum, when necessary, from the neck of the tooth, the latter should be grasped with a pair of straight forceps (Fig. 528 or Fig. 530, or, in case the tooth is a lateral incisor, with a narrow crown, Fig. 529), and pressed several times in quick succession outward and inward, giving it at the same time slight rotary motion, which should be continued until it begins to give way; then, by a slight downward pull, it is

easily removed. If the tooth is much decayed, it should be grasped as high up under the gum as possible, and no more pressure applied to the handles of the instrument than may be necessary to prevent it from slipping. Teeth are often unnecessarily broken by not attending to this precaution.

The same directions will, in most cases, be found applicable for the removal of a lower incisor. But the arrangement of these teeth is sometimes such as to render their extraction rather more difficult. The forceps best calculated for their removal are represented in Figs. 531 and 533.

For the extraction of a cuspid more force is usually required than for the removal of an incisor, because of the greater size and length of its root. The straight forceps (see Fig. 528 or Fig. 530) should be employed for the removal of the superior, and the curved-beaked forceps (Figs. 531, 536, and 545) for the inferior cuspids. In the ex-

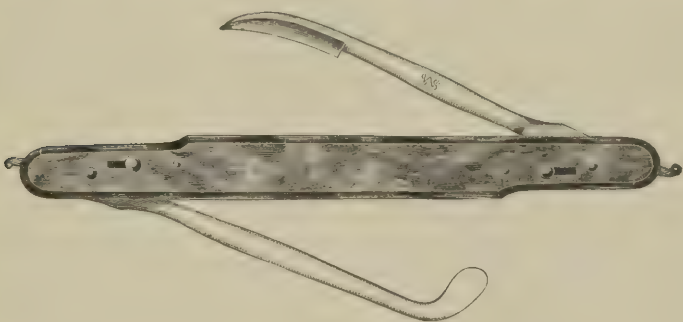


FIG. 559.

traction of these teeth less rotary motion should be given to the hand than in the removal of the incisors; in every other respect the operation is performed in the same manner. The inferior cuspids usually have longer roots, and are more difficult to remove than the superior.

Very little rotary motion can be given to a bicuspid, especially an upper one, in its extraction. After it has been pressed outward and inward several times, or until it begins to give way, it should be removed by pulling in the direct line of its axis. For the extraction of the upper, the forceps represented in Fig. 528 and Fig. 530, and for the lower, those represented in Fig. 536 and Fig. 545 are the proper instruments to be employed, unless the crown has become so much weakened by decay that it will not bear the requisite amount of pressure. In this case the gum on each side should be separated from the alveolus about an eighth or three-sixteenths of an inch, and slitted so as to permit the application of the narrow-beaked forceps, Fig.

531. With these the alveolar wall on each side may be easily cut through, and a sufficiently firm hold obtained upon the root of the tooth for its removal. The forceps represented in Fig. 565 and Fig. 566 will be found better adapted for the removal of the molars, when in a similar condition, than any other instrument.

The upper molars, having three roots, generally require a greater amount of force for their removal than any of the other teeth. They should be grasped as high up as possible, with one of the forceps represented in Fig. 522 or 523, and then pressed outward and inward until the tooth is well loosened, when it may be pulled from the socket. If the forceps used for the extraction of the upper molars are of the right description and properly applied, they will be found the safest and most efficient instruments that can be employed for their removal.

The superior dentes sapientiæ are usually less firmly articulated to the jaw than are the first and second molars; they are therefore more easily removed. When their crowns are sufficiently long to admit of being grasped with the bicuspid forceps (Fig. 535), they may be removed with this instrument; but when this cannot be applied without interfering with the anterior teeth, the forceps represented in Fig. 536 may be substituted.

The inferior molars, although they have but two roots, are often very firmly articulated, and require considerable force for their removal; and it sometimes happens that, when the approximal side of one has been destroyed by caries, the adjoining tooth has impinged upon it in such a manner as to constitute a formidable obstacle to its extraction. Two teeth are often removed in attempting to extract one thus situated, unless the precaution is taken of cutting away the side of the encroaching tooth. This should never be omitted in the extraction of a lower molar or bicuspid locked in the manner just described. It sometimes, though less frequently, happens that the upper teeth impinge upon each other in the same manner; in this case, also, the adjoining tooth should be cut away sufficiently to liberate the one that is to be extracted before attempting its removal. In applying forceps to an inferior molar, the points on the beak of the instrument should be forced down between the roots; after having obtained a firm hold, the tooth should be forced inward and outward several times in quick succession, until its connection with the jaw is partially broken up, and then raised from the socket. If the tooth has decayed down to the neck, the points of the beak may include the upper edge of the alveolus, through which they will readily pass on applying pressure to the handles, and in this manner a secure hold will be obtained upon the tooth. The same should also be done in the extraction of a superior molar in this condition.

The dentes sapientiæ in the lower jaw, when situated far back under the coronoid process, are oftentimes exceedingly difficult to extract; but with forceps like those represented in Figs. 524, 527, or 545, they may always be grasped by an expert operator, except in those cases where their crowns have been destroyed by caries, when the cowhorn forceps represented in Fig. 567 will generally prove useful. It occasionally happens that the roots of these teeth are bent in such a manner as to constitute a considerable obstacle to their removal. But when this is the case, the roots are almost always turned posteriorly toward the coronoid processes; so that after starting the tooth, if the operator is unable to lift it perpendicularly from the socket, he will have reason to suspect its retention to be owing to an obstacle of this nature. To overcome this, as he raises his hand he should push the crown of the tooth backward, making it describe the segment of a circle; for should he persist in his efforts to remove it directly upward, the root will be broken and left in the jaw. Fig. 538 represents an elevating forceps useful in removing the dentes sapientiæ when they are but partially erupted or badly decayed. The points of the beaks of this forceps are inserted between the second molar and partially erupted wisdom tooth, the crown of the second molar being the fulcrum.

It sometimes happens that the roots of the first and second molars of both jaws and those of the superior dentes sapientiæ are bent, or else diverge or converge so much as to render their extraction exceedingly difficult. The convergency of these roots is often so great that, in their removal, the intervening wall of the alveolus is brought away; but neither from this, nor from the removal of a small portion of the exterior wall, will any unpleasant results follow. Similar malformations are occasionally met with in the roots of the bicuspids, the cuspids, and even the incisors.

Other obstacles sometimes present themselves in the extraction of teeth, which the judgment and tact of the operator alone will enable him to overcome. The nature and peculiarity of each case will suggest the method of procedure most proper to be pursued. The dentist should never hesitate to embrace a portion of the alveolus between the jaws of the forceps when necessary to enable him to obtain a firm hold upon the tooth. The removal of the upper edge of the socket is never productive of injury, as it is always subsequently removed, more or less rapidly, by the process of absorption. When the crown of a tooth has become so much weakened by disease that it will not bear the pressure of the instrument, it may be removed in this manner without inflicting upon the patient half the pain that would be caused by the attempt to spare the thin, perishable alveolar walls.

MANNER OF EXTRACTING ROOTS OF TEETH.

The extraction of roots of teeth is sometimes attended with considerable difficulty; but generally they are more easily removed than the whole teeth, especially the roots of the molars, for, after, the destruction of their crowns, an effort is usually made by the economy to expel them from the jaws. This is done by the gradual absorption of the alveolus, together with the filling up of the socket by a deposition of ossific matter at the bottom, whereby the articulation of the root becomes weakened and its removal rendered proportionately easier. The alveolar cavities are often wholly obliterated in the course of two or three years after the destruction of the crowns of the teeth, and the roots retained in the mouth simply by their connection with the gums, so that for their removal little more is necessary than to sever this bond of union with a lancet or sharp-pointed knife.

The instruments usually employed in the extraction of roots of teeth are the hook, punch, elevator, and screw, all of which are represented in Fig. 560, and also the root forceps shown in subsequent figures. Although every dentist has the former made to suit his own peculiar notions, the manner of using them and the principles upon which they act are the same. It will, therefore, be sufficient to say that they should be of a convenient size, made of good steel, and so tempered as neither to bend nor break.

The hook, No. 7, Fig. 560, is chiefly used for the extraction of the roots of molar and bicuspid teeth on the left side of the mouth; the punches, Nos. 3, 4, 5, 6, 10, 11, 12, Fig. 560, for the removal of those on the right side; the elevators, Nos. 2, 8, 9, 13, Fig. 560, for the extraction of roots on either side, as occasion may require; and the screw, No. 1, Fig. 560, for the removal of those of the upper front teeth.

Considerable tact is necessary for the skillful use of these instruments, and this can only be obtained by practice. Great care is requisite, in using the punch and elevator, to prevent them from slipping and injuring the mouth of the patient. Whenever, therefore, either of these are used, the forefinger of the left hand of the operator should be wrapped with a napkin and placed on the side of the root opposite to that against which the instrument is applied, so as to catch the point in case it should slip.

But for the removal of the roots of bicuspids and molars, and often for those of the cuspids and incisors, the narrow-beaked forceps recommended for the extraction of the lower incisors (see Fig. 531) may be used more effectively than any other instrument. When the root is

decayed down to the alveolus the gum should be separated from it, and so much of it as may be necessary to obtain a secure hold upon the root included between the beaks of the forceps, for these, being very narrow, readily pass through the alveolus, and a firm hold is at

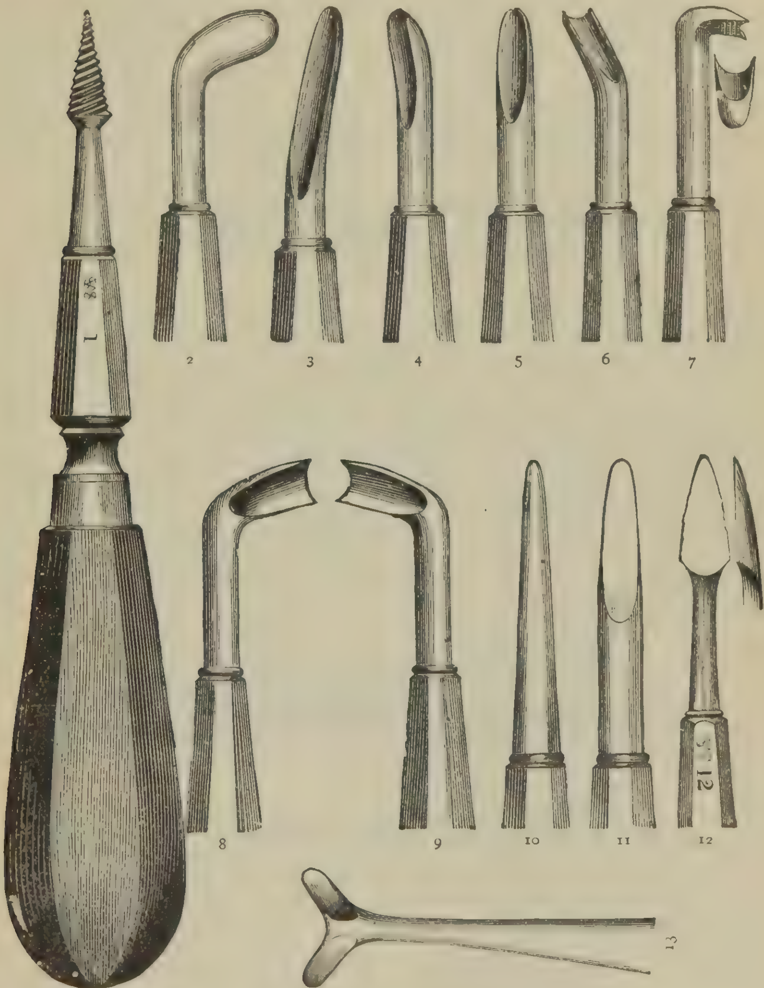


FIG. 560.

once obtained upon the root; then, after moving it a few times outward and inward, it may easily be removed from its socket.

There are some cases, however, in which the punch, hook, and elevator may be advantageously used. We have also occasionally met

with cases where we have succeeded in removing roots of teeth with great ease by means of an elevator shaped like the blade of a knife, first forcing it into the socket by the side of the root and then turning it so as to make the back press against the former and the edge against the latter. When this instrument, represented in Fig. 561, is used, the blade should not be more than an inch in length, and it should be straight, short at the point, and have a very thick back, that it may not break in the operation. In using the common elevator it is necessary that there should be an adjoining tooth or root to act as a fulcrum. When this can be employed, a root, or even a whole tooth, may some-

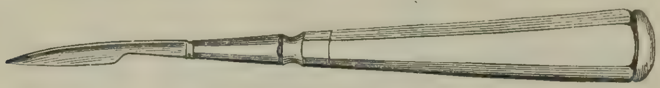


Fig. 561.

times be removed with it; but, as a general rule, forceps should be preferred to any of these instruments.

For the extraction of the roots of the upper front teeth, after they have become so much funneled out by decay as to render their walls incapable of sustaining the pressure of forceps, the conical screw may be employed. With this a sufficiently firm hold for the removal of the root may be obtained by screwing it into the cavity. But before it is introduced the soft decomposed dentine should be removed from the interior of the root with a triangular-pointed instrument like the one represented in Fig. 562.

Dr. S. P. Hullihen has invented a most valuable and useful instru-

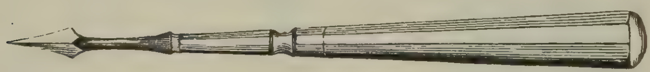


Fig. 562.

ment for the removal of the roots of the superior incisors and cuspids when in the condition just described. It combines the advantages both of the screw and forceps, as may be seen by the accompanying cut. It is thus described by the author: "Lengthwise, within and between the blades of the beak, is a steel tube, one end of which is open, the other solid and flat, and jointed in a mortise in the male part of the joint of the forceps. When the forceps are opened, this joint permits the tube to fall backward and forward from one blade of the beak to the other, without any lateral motion. Within this tube is a spiral spring, which forces a shaft up two-thirds of the tube; the other part is a well-tapered or conical screw. . . . The shaft and tube are so fitted together and to the beak of the forceps that one-

half of the rounded part of the shaft projects beyond the end of the tube, so that the shaft may play up and down upon the spring about half an inch, and the screw or shaft be embraced between the blades of the beak of the instrument."

Dr. Hullihen's instrument is represented in Fig. 563.

"The forceps," says Dr. Hullihen, "are used by first embracing the shaft between the blades.* Then, screwing it as gently and deeply

FIG. 563.

into the root as possible, the blades are opened and pushed up on the root, which is then seized and extracted. The screw thus combined with the forceps prevents the root from being crushed. It acts as a powerful lever when a lateral motion is given; it is likewise of advantage when a rotary motion is made; it prevents the forceps from slipping or from losing their action should one side of the root give way in the act of extracting it, and is used with equal advantage where one side of the root is entirely gone."

Fig. 564 represents Dubs's screw forceps: 1. Conical screw, with

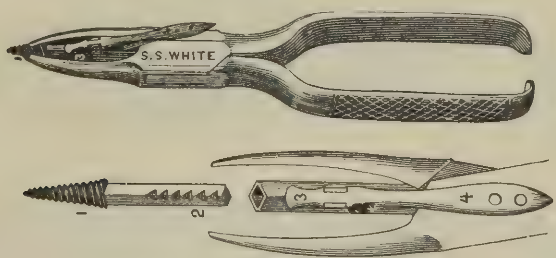


FIG. 564.

square ratchet shaft. 2. Beaks of forceps, grooved inside. 3. Socket with square hole to receive shaft. 4. Spring trigger, by which the screw can be detached at pleasure at any given point.

For the extraction of the roots of the upper molars before they have

* The author has a pair constructed so that the blades of the beak of the forceps grasp the upper extremity of the screw instead of the shaft.

become separated from each other by decay, the forceps (Fig. 565) invented by Dr. Maynard will be found highly valuable. The outer beak of each instrument is brought to a sharp point for perforating the alveolus between the buccal roots and for securing between them a firm hold, while the inner beak is intended to rest upon the edge of

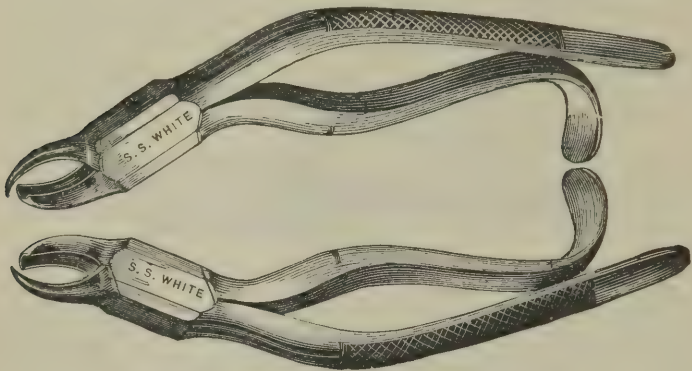


FIG. 565.

the alveolus and embrace the palatine root. By this means a sufficiently firm hold is secured to enable the operator to remove the roots of an upper molar without difficulty. Two pairs, as represented in the engraving, one for the right and one for the left side, are required.

Fig. 566 represents a form of forceps recently introduced, which

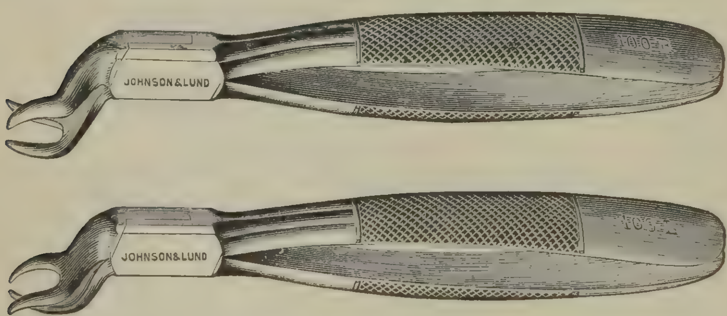


FIG. 566.

is also used for the extraction of the roots of the superior molars before they have become separated by decay; a right and left are required.

Fig. 567 represents a lower molar cowhorn forceps for either side; right and left forceps of this pattern are also used.

Fig. 568 represents a lower molar cowhorn forceps for either side, one beak being longer than the other.

The advantage to be derived from forceps of this description must be apparent to every dentist.

FIG. 567.

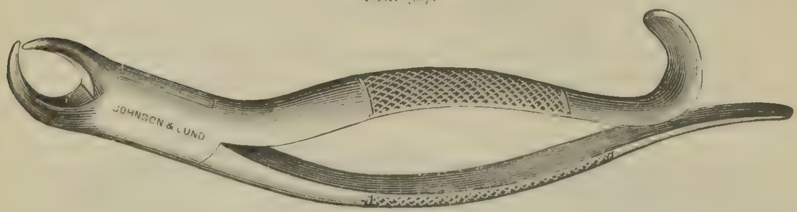


FIG. 568.

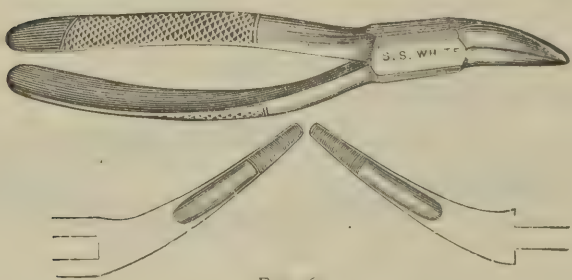


FIG. 569.

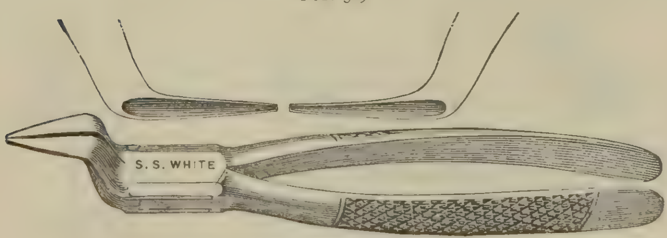


FIG. 570.

Fig. 569 represents Tomes's universal root forceps, which is a very useful form for the extraction of fragments and small roots of teeth.

Fig. 570 represents Arrington's bayonet-shape, slender beak for-

ceps for the extraction of difficult roots in the upper jaw and roots of front teeth in the lower jaw.

Figs. 571 and 572 represent front and back alveolar nipping for-

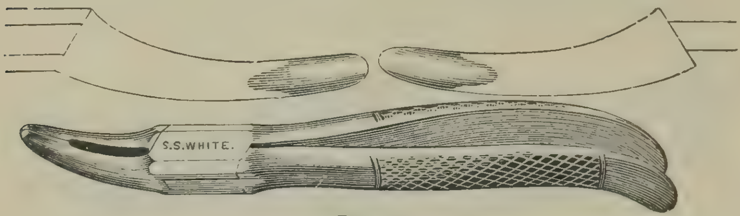


FIG. 571.

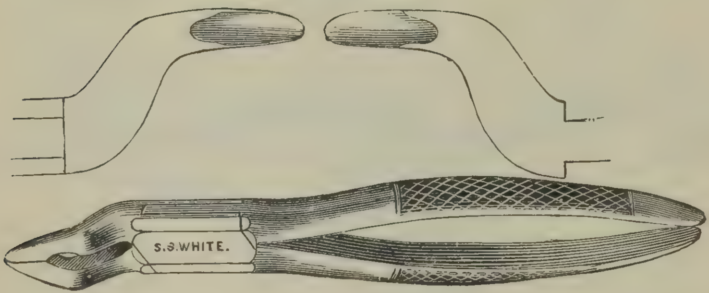


FIG. 572.

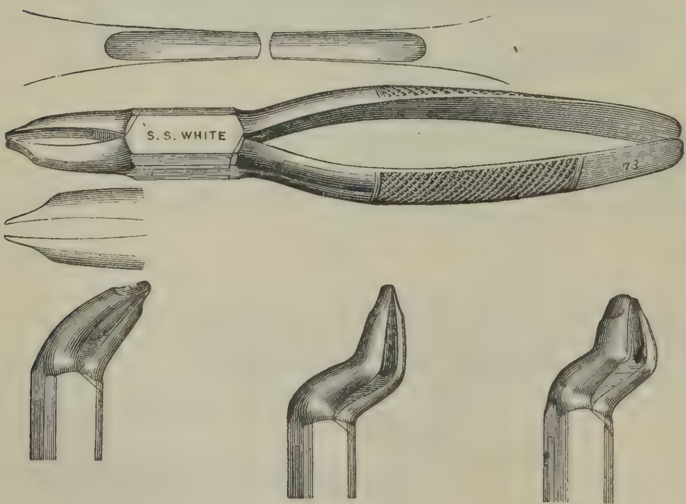


FIG. 573.

ceps, for cutting away processes after extraction, and which may also be used for removing roots of teeth.

Fig. 573 represents Tees's sub-alveolar thin-pointed forceps, which

are designed to slip within the alveolar process and into the tooth-socket to remove teeth the crowns of which are entirely decayed or broken off.

EXTRACTION OF THE TEMPORARY TEETH.

The temporary teeth should be extracted in the same manner as the permanent, and with the same instruments. If the power be properly directed very little force is required for their removal, because the roots of these teeth have generally suffered more loss of substance before the operation is called for; and when they remain, the alveolar processes at this early age are so soft and yielding as to offer little resistance to the tooth.

The operator should be careful not to injure the pulps of the permanent teeth or the bone of the jaw. Serious accidents sometimes occur from an improper or awkward removal of these teeth. But, as has been before remarked, their extraction is seldom required. It should only be resorted to for the relief of toothache, the cure of alveolar abscess, to prevent irregularity in the permanent teeth, or in case of necrosis of the socket. And even in such cases it is necessary to exercise much judgment in deciding how far pain and inconvenience should be endured rather than extract the offending tooth; or how far the chance of injury to the permanent teeth demands the removal of the diseased temporary teeth. Their premature extraction is so often followed by a crowded state of the permanent teeth, that their indiscriminate removal for trifling causes cannot be too strongly condemned.

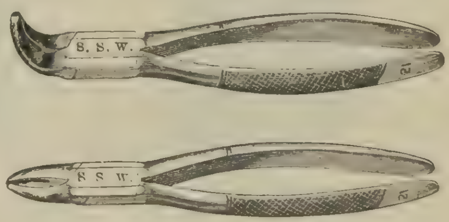


FIG. 574.

Fig. 574 represents forceps, curved and straight, for the extraction of children's teeth.

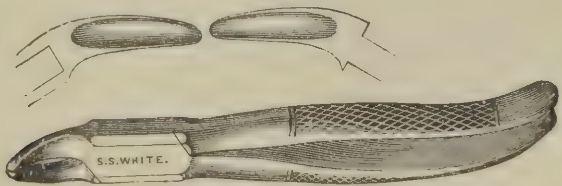


FIG. 575.

Fig. 575 represents forceps for the extraction of children's teeth, and which will also answer as universal root forceps.

The possibility of septic affections in connection with the extraction

of teeth, such as necrosis of jaws, diffuse abscess, erysipelas, etc., is now universally admitted, hence the necessity existing for antiseptic precautions, such as the effective sterilization of all instruments employed. The immersion of instruments in a boiling one or two

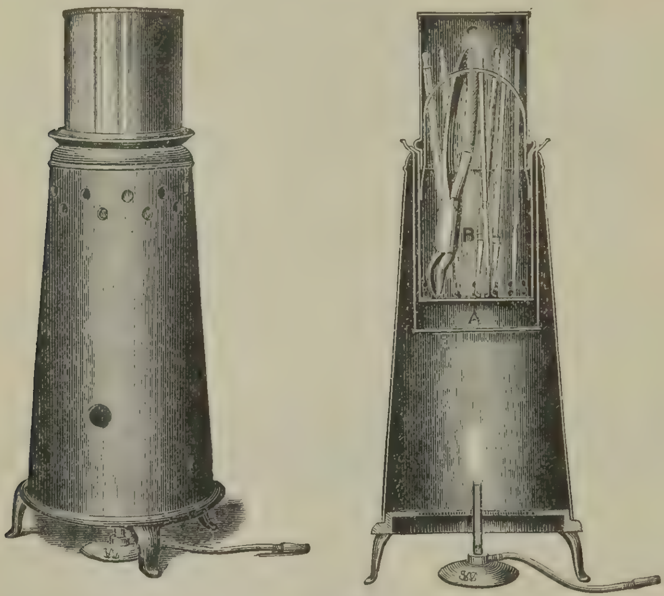


FIG. 576.

per cent. solution of soda will answer such a purpose. Fig. 576 represents Dr. E. D. Downs's apparatus for sterilizing instruments.

HEMORRHAGE AFTER EXTRACTION.

It rarely happens that excessive hemorrhage follows the extraction of a tooth. Indeed, it is oftener more desirable to promote bleeding by rinsing the mouth with warm water than to attempt its suppression, especially after the extraction of teeth affected with periodontitis, as such hemorrhage relieves the congestion of the parts and hastens recovery. Nevertheless, cases do sometimes occur in which it becomes excessive and alarming. It has been known in some instances to terminate fatally; this, however, does not appear to be dependent upon the manner in which the operation is performed, but rather upon a hemorrhagic diathesis of body, attributable to a deficiency in the coagulating property of the blood, a defibrinating condition, or hereditary predisposition. Hence, whenever a tendency to it exhibits itself in one member of a family, it is usually found to exist in all.

There are two forms of hemorrhage—the "primary," which immediately follows the extraction of a tooth, and the "secondary," which occurs after the arrest of the primary. A patient may have a tooth extracted during the day, and no unusual hemorrhage result, which is the common experience; but during the night, or the next day, or even later, a serious flow of blood may ensue, which is secondary hemorrhage, and more difficult to arrest than the primary form. Of the many cases which have fallen under our own observation, we shall mention only the following:—

In the fall of 1834 Miss I., fifteen years of age, had the second molar on the left side of the upper jaw removed. The hemorrhage immediately after the operation was not greater than usually occurs, and in the course of half or three-quarters of an hour it ceased altogether. But at about twelve o'clock on the following night it commenced again, the blood flowing so profusely as to excite considerable alarm. A messenger was immediately sent to ask our advice, and we directed that the alveolar cavities should be filled with pledgets of lint, saturated with tincture of nutgalls. Two days after, at about six o'clock in the morning, we were hastily sent for by the young lady's mother, and when we arrived at her residence we were informed that the bleeding had been going on for about four hours. During this time more than two quarts of blood had been discharged. The blood was still oozing very fast. After we had removed the coagulum we filled the socket with pieces of sponge, saturated, as the lint had been, with tincture of nutgalls. When firmly pressed in and secured by a compress, the hemorrhage ceased. These were permitted to remain until they were expelled by the suppurative and granulating processes. We afterward had occasion to extract one tooth for a sister and two for the mother of the young lady, and a hemorrhage similar to that just described occurred in each case. Where the tendency to hemorrhage exists, due care should be exercised, immediately after the extraction of teeth, to guard against its occurrence by the application of a reliable styptic. Some of the more simple local remedies for its arrest are spider-web as a mechanical obstructor; also compressed sponge saturated with sandarac varnish or coated with soft wax; the return of single-root teeth, coated with wax, to the cavity; the lint of black silk, owing to the efficacy of the coloring matter; the scrapings of leather, on account of the tannin used in preparing it; lint of old linen, saturated with phenol sodique, all of which may be packed into a bleeding cavity after freeing it from blood, and kept in place, if necessary, by a compress; also the adaptation of a rubber plate accurately to the part, or of modeling composition as compresses for the retention of the styptic; also alum; also matico leaf, prepared by

immersing a piece in water for a few minutes and rolling it into pellets, or into a cone, with the under surface of the leaf outward, and packing these into the cavity, after which a compress is applied, and also a bandage round the head and under the chin to keep the mouth at rest. The more powerful styptics for local application consist of tannic acid, gallic acid, nitrate of silver, tincture perchlorid of iron, solution of persulphate of iron, powdered subsulphate of iron. A styptic and antiseptic cotton is prepared by saturating purified cotton with tannic acid five parts, carbolic acid four parts, and alcohol fifty parts; the cotton is dried and preserved air-tight. Tannin is an excellent styptic, and answers well in connection with the compress of lint or cotton in most cases, also gallic acid, and their clots are not soluble in the blood. The tincture perchlorid of iron and the solution persulphate of iron, although powerful styptics, are not reliable, on account of the danger of sloughing and the occurrence of secondary hemorrhage. The same is the case with the nitrate of silver, the use of which, although it may prove successful in some cases, is attended with destruction of tissue, and its clot is soluble in the blood. The powdered subsulphate of iron (Monsel's) applied to the bleeding cavity on pledgets of cotton saturated with sandarac varnish, with a compress so adjusted as to act directly upon the mouth of the bleeding vessel, will generally prove effectual in arresting alveolar hemorrhage. The compression should be moderate, and the packing be allowed to remain until all danger of a return of the bleeding is past. In many cases of severe alveolar hemorrhage it is better to allow the packing to come away of itself. Constitutional treatment is frequently necessary in connection with the local treatment, and such internal remedies as acetate of lead, two grains; opium, one grain; tincture of perchlorid of iron, ♏ xv–xxx; gallic acid, gr. v–x; tincture of erigeron canadensis, gtt. j, every minute; dilute hydrochloric acid, gtt. xv in a wineglass of water every four hours, will prove serviceable in obstinate and severe cases. Veratrum viride, in doses of gtt. v to water ℥ ss, will depress the action of the heart, and, as a consequence, prove beneficial. Dr. W. L. Roberts, uses three grains of tannic acid in one-third glass of water, giving as a dose two teaspoonfuls of this solution every five minutes until three doses are taken; then two teaspoonfuls every fifteen minutes if required. Rest, and the horizontal position, with the head and shoulders raised, are valuable adjuncts to the treatment. In some cases it may be found necessary to have recourse to the actual cautery. (See Gorgas's *Dental Medicine* for further details on alveolar hemorrhage.)

The late Professor Gross was the first to call attention to a form of neuralgia occurring after the extraction of teeth, and depending upon

thickening and induration of the alveolar margin, by which the remains of the dental nerves after the removal of teeth become compressed and irritated. The treatment in such cases consists in the removal of the margin of the alveolus compressing the nerve with cutting forceps, and thus freeing the irritated tissue.

CHAPTER VI.

THE USE OF ANESTHETIC AGENTS IN THE EXTRACTION OF TEETH.

Of the various agents that have been employed for the prevention of pain during surgical operations, sulphuric ether and chloroform have been more generally used than any others. The practicability of producing anesthesia with ether was first demonstrated by Dr. Horace Wells, of Hartford, Conn., in 1846, and soon afterward brought prominently before the medical and dental professions by Dr. W. G. S. Morton, of Boston, Mass., both practical dentists; and with chloroform, in 1847, by Prof. J. Y. Simpson, of Edinburgh, Scotland. The anesthetic effect is obtained by inhalation of the vapor, and is supposed to be nothing more than a transient state of intoxication, which usually disappears almost immediately after the discontinuance of the administration, though in many cases it has proved fatal. For this reason we do not think that agents capable of producing such powerful and dangerous effects as ether and chloroform should be used in so simple an operation as the extraction of a tooth. The first, however, is less dangerous than the second; but its anesthetic effect is less certain and prompt, from seven to ten minutes being usually required, whereas, with the other, it is obtained in from thirty seconds to two minutes. When ether is used, from six to ten or fifteen ounces are employed; but with chloroform it is rarely necessary to administer more than thirty to one hundred and fifty drops. What we have said about sulphuric ether applies equally to chloric ether, a substance very extensively used, if not first proposed, by the late Prof. Warren, of Boston.

A number of instruments have been devised for the inhalation of the vapor of these agents; but the simplest method of administration is from a hollow sponge, a napkin, or a pocket handkerchief.

It may not always be possible for any one, in the administration of either of the foregoing agents, even to a person supposed to be free from any special proclivity to disease from organic derangement, to pronounce, *à priori*, that no bad effect will result from it; but all agree

that it is unsafe to give it to a patient laboring under disease of the heart, brain, or lungs. The practitioner, therefore, whether medical or dental, should be well assured, before giving ether or chloroform, and especially the latter, that these organs are not only free from disease, but also from any morbid tendency, as ignorance with regard to this matter might lead to fatal consequences. It should be given cautiously under any circumstances, and the pulse should never be permitted to fall, during the inhalation, below sixty, or, at least, fifty-five beats a minute; but if, from carelessness or any other cause, the patient should sink and the pulsation cease, the agent should be immediately removed from the mouth, and if occupying a sitting posture he should be placed in a reclining position, air freely admitted, cold water dashed in the face, the feet and hands rubbed with hot salt or mustard, and, if necessary, artificial respiration made and galvanism applied. In addition to these means the tongue should be depressed and drawn forward by a finger thrust deeply into the mouth, as recommended by Ricord; or Marshall Hall's or Sylvester's or Howard's methods may be faithfully and patiently practiced. Ellis gives the following simplified formula of his method for cases of asphyxia from drowning: "Instantly place the patient on the face and side, supporting the head. Unfasten the clothes about the neck and chest, braces, etc. Wipe and clean the mouth and nostrils. Raise and support the chest on a folded coat or bundle. Roll the patient constantly and gently from the face to the side, and back again, occasionally changing the side, supporting the head. On the completion of each turn to the face make a brisk pressure on the back, between and below each shoulder blade. Dry and rub the patient briskly, rubbing upward."

The inversion of the body, a method devised by the celebrated French surgeon Nélaton, has been resorted to successfully. Nitrite of amyl, a powerful stimulant, has been successfully inhaled in cases of chloroform necrosis with dangerous symptoms, but care is necessary in its use; and not more than ♏ij should be administered by inhalation to persons unaccustomed to its effects.

It is thought by those who have had most experience in the use of ether and chloroform as anesthetic agents that their administration is attended with less danger when the patient is in a reclining than when in a sitting posture. It would be well, therefore, when ether is used preparatory to the extraction of teeth, to place the patient as nearly as possible in such a position; when the dentist is provided with an operating chair having a movable back, this can be very readily done.

Nitrous Oxid Gas is more generally employed as an anesthetic in the practice of dentistry than any other, and the immunity from accident with which it is administered is an evidence of its safety when

compared witn chloroform and some other general anesthetics; due care, however, should be exercised in the use of all general anesthetics.

The anesthetic effect of nitrous oxid, or laughing gas, was first suggested by Sir Humphry Davy, in 1776, and practically demonstrated

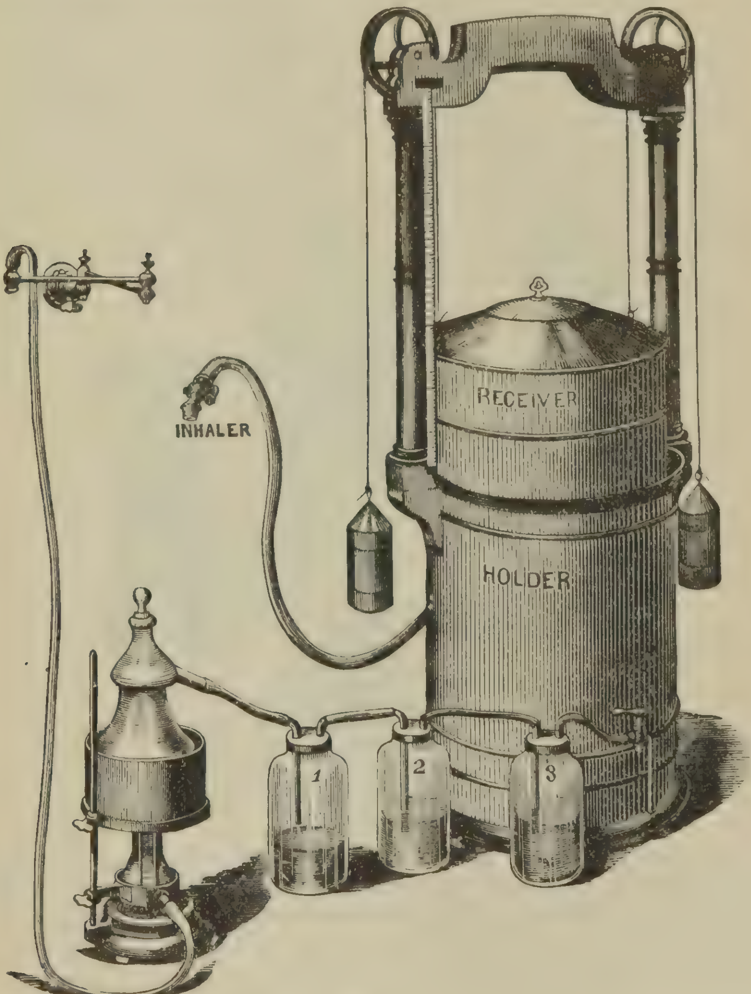


FIG. 577.

by Dr. Horace Wells. This gas is manufactured from the salt nitrate of ammonia, either in a fused or granulated form, by slowly melting and boiling it in a glass retort, over a sand bath, until nearly all of the nitrate is decomposed. The gas, on leaving the retort, passes through

several wash bottles, one of which contains either a solution of the sulphate of iron or caustic potash, and the other two pure water, for the purpose of purifying it before it enters a holder and receiver, from which it is administered to the patient by means of an inhaling tube. One pound of the granulated nitrate of ammonia will produce about thirty gallons of the gas, which should be administered to the patient in a pure state—unmixed with atmospheric air.

Fig. 577 represents an apparatus for generating nitrous oxid gas.

Liquefied Nitrous Oxid is, however, a more convenient form for use. To obtain this form the nitrous oxid gas, after being subjected to intense cold and pressure, is condensed in the form of a liquid, in a strong iron cylinder, one hundred gallons of the gas weighing but ten pounds, and capable of being condensed into a cylinder.

Fig. 580 represents the Justi gas cylinder holder for use in the operating room. To this cylinder holder the bag and inhaler, with metal

Fig. 578.

Fig. 579.

mouth shield, are attached. When it is desired to administer ether, the end tube, to which the rubber tubing is connected, can be unscrewed, and the globe, which contains a sponge to hold the ether, attached in its stead.

In administering this gas for dental operations, the patient is seated in an operating chair with a movable back, a cork or piece of wood to which a string is attached placed between the jaws, or, what is better, a soft rubber bite-block, of which four sizes are made, Fig. 578, which do not need a string, as they are readily removed with the crooked fingers, and are too large to be swallowed. Fig. 579 represents Daintree's adjustable mouth-prop.

The operator, who occupies a position on the right side of the patient, supports the inhaler with his right hand, some of the fingers of which press the lower lip tightly about the mouth-piece. The thumb and index finger of the left hand close the nostrils, while the

remaining fingers press the upper lip about the mouth-piece of the inhaler. The patient is then instructed to make long but otherwise natural inspirations, one of the valves of the inhaler permitting the exhalations to pass off.

After thus inhaling the gas for a few minutes, its anesthetic effects are shown by strong involuntary respirations attended by a snoring sound, owing to the relaxation of the muscles of the pharynx. Then follows a livid appearance of the lips, from the discolored blood in the capillaries. A spasmodic twitching of the muscles is observed at

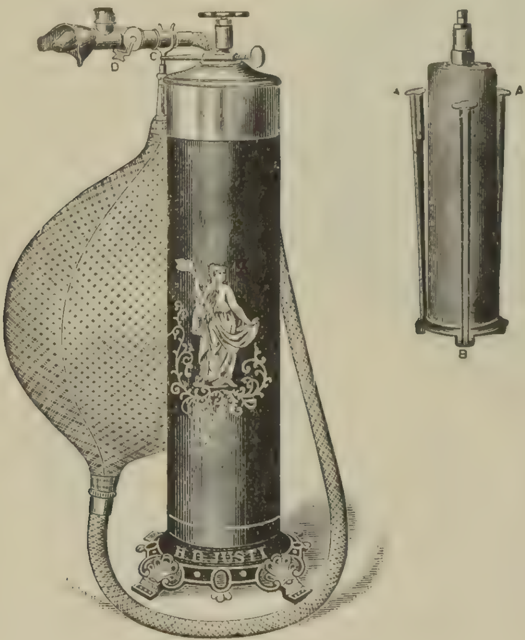


FIG. 580.

this stage in many patients, when complete narcosis follows. The narcotic effects of the gas continue from thirty seconds to one and a half minutes, and the number of teeth which can be extracted varies from four to twelve. It is no unusual occurrence, however, for the extraction of one tooth to consume the entire time the patient is under the narcotic influence of the gas, while in other cases more than the highest number just mentioned may be removed before the patient becomes conscious of pain.

Fig. 581 represents rubber inhaler hoods, which fit closely to the

face without unpleasant pressure, such as may be caused by the metal mouth-shield.

Nitrous oxid gas is considered to be the safest general anesthetic now in use, and does not produce the nauseating and debilitating effects which are often caused by ether and chloroform. Extreme caution, however, is necessary in administering this gas under circumstances which prohibit the use of other general anesthetic agents. The greatest objection to the use of this gas, aside from the question of safety, is the rapidity in operating which its transient effect necessitates; and it is much better to carefully extract a few teeth than to attempt the removal of many by an operation which may be attended with severe laceration of the gums and fracture of the alveolus.

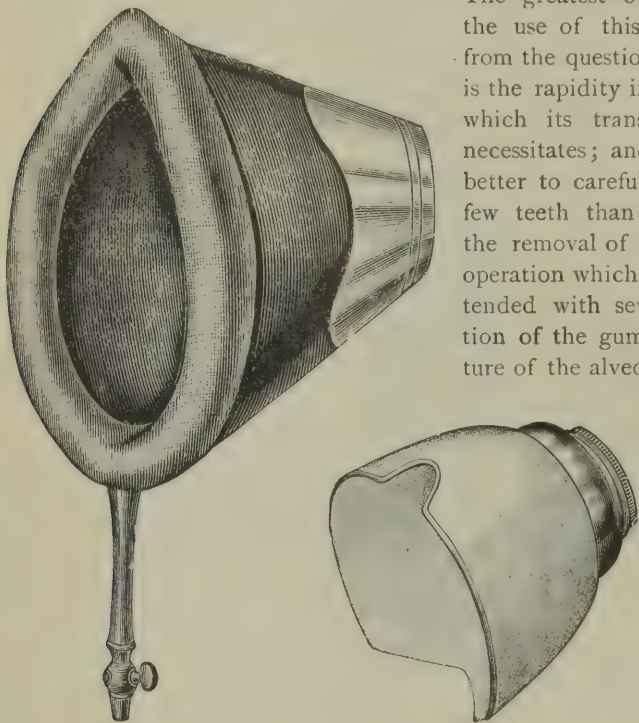


Fig. 581.

Bromid of Ethyl.—Hydrobromic ether is obtained from bromid of potassium and sulphuric ether, by distillation, and by redistillation with chlorid of lime. Although a pleasant anesthetic and very prompt in its effect, yet its administration is not without danger, and hence caution is necessary in its employment. It is administered in the same manner as ether or chloroform, and recovery from its influence is more rapid than with either of these agents. From thirty seconds to five minutes are required to manifest its anesthetic effects. The quantity required differs, according to the susceptibility of the patient,

the usual rule being to commence with one dram, then administer a second, and if necessary a third dram may be inhaled in two minutes after the administration of the second dram. Two drams will, however, in most cases, be sufficient to cause profound anesthesia.

Dr. B. W. Richardson, of London, introduced an anesthetic agent, known as the *bichlorid of methylene*, which is formed by the action of sulphuric acid on zinc in chloroform. It differs, however, from chloroform, in the circumstance that one atom of chlorin is replaced by one atom of hydrogen. Bichlorid of methylene produces as great a degree of insensibility as chloroform, and its action is more rapid and the narcotism very prolonged. It also interferes less with muscular irritability than either ether or chloroform, and the recovery from its effects is sudden; but more of it is required. When it destroys life, as it has in several cases, the respiring and circulating functions are equally paralyzed.

Hydrate of chloral is another general anesthetic agent which has been extensively employed. Chloral is by no means a new anesthetic, Liebig having discovered it in 1830; but, as Dr. B. W. Richardson states, the introduction of it into medicine is a fact of the year 1871, its introducer being Liebreich, of Berlin.

The hydrate is made from the chloral by the simple addition of a little water, and on the application of heat solidifies into a white crystalline substance.

The manner in which hydrate of chloral is administered is in solution with water, either by the mouth directly into the stomach, or by subcutaneous injection. The best solution is made by mixing one grain of the hydrate with two of water. Dissolved in an excess of water, the taste is agreeable, with the odor of a ripe melon. It is administered to human subjects in doses varying from 25 to 30 grains, causing unconsciousness to pain and a profound sleep lasting over several hours. The sleep is gentle and quiet, induced without distress, and leaving no other symptom behind except nausea, which is occasionally experienced after recovery. In administering this agent, it appears to act more promptly when subcutaneously injected than when administered directly by the mouth; and as chloral dissolved in water is slightly caustic, it cannot be administered by the mouth when there are lesions of mucous membrane or ulcerated tracts of intestinal canal. In administering hydrate of chloral to the human subject, Dr. Richardson states that allowance will have to be made not only in relation to size and weight, but to obesity or leanness, to natural habit and actual state of body in respect to sensibility.

Fig. 582 represents the full size of a hypodermic syringe with graduated rod and steel points.

Local Anesthetics.—Suspension of nervous sensibility induced by inhaling the vapor of ether, chloroform, nitrous oxid, bromid of ethyl, etc., is general, every part of the body being affected alike; but partial or local anesthesia may be procured by other and less dangerous means. Congelation or freezing, first proposed and employed in the Charity Hospital, Paris, by an *interne* of M. Velpeau, and subsequently recommended by Dr. James Arnott, of London, was formerly resorted to both by surgeons and dentists, and practiced to a limited extent with success. This may be effected by applying a mixture of pounded ice and common salt, in the proportion of two or three parts of the former to one of the latter, to the part on which the operation is to be performed. But in the use of this care is necessary to prevent reducing the temperature too much, as in this case loss of vitality would be occasioned by it. We have heard of a few cases in which this has occurred, but we believe it was owing in every instance

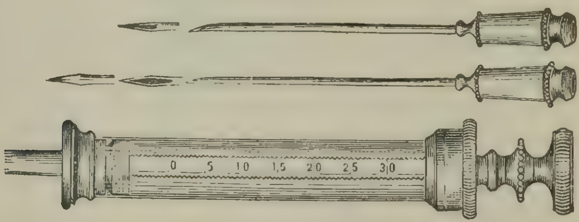


FIG. 582.

to carelessness or want of judgment on the part of the operator as to the length of time the application of the mixture should be continued.

Several instruments have been invented for the application of this freezing mixture to teeth preparatory to extraction. One of the first adapted for the purpose was designed by Dr. Branch, of Chicago, Ill. It consisted of a hollow tube about an inch or a little more in diameter, with about five-eighths of an inch cut out at one end, on either side, that it might readily be passed over a tooth. To this was attached a sac of finely prepared membrane, large enough to hold a tablespoonful of the mixture. The hollow of the tube was occupied by a steel wire spiral spring. Just before using it a sufficient quantity of the freezing mixture was put in the tube; the end of the latter was placed over the tooth, when the ice and salt were forced up gently around it by pressing on the spring at the other extremity of the instrument. Two tubes were employed, one straight, for teeth in the anterior part of the mouth, the other bent near one end for the more convenient application of the mixture to a molar tooth.

The sudden application of such intense cold to a sensitive tooth, or

to one which has not lost its vitality, is often productive at first of severe pain : on this account many objected to its use, preferring the momentary suffering consequent upon the operation of extraction rather than that occasioned by the freezing mixture. But this effect is rarely experienced in its use on dead teeth, or the roots of teeth which have lost their vitality ; hence, the application of it to such teeth proved more satisfactory than to living teeth.

In the year 1858 Mr. J. B. Francis, dentist, of Philadelphia, announced the discovery of an original method of producing local anesthesia, said to be peculiarly applicable to the extraction of teeth, which consists in passing an electro-galvanic current through the tooth at the moment of its removal. The discovery was submitted to the Franklin Institute, Philadelphia, and the committee to whom it was referred for examination, composed in part of dentists, reported favorably in regard to the claims of the inventor. One of the members of the committee, W. S. Wilkinson, stated that he had extracted between four and five hundred teeth, applying the electric current, and that in ninety-five per cent. of the cases it was done without pain to his patients.

The method of applying it is very simple. One pole (the negative is preferable) of the electro-galvanic machine is attached to one of the handles of the forceps by means of a flexible conductor, while the metallic handle of the other is grasped by the patient, the power of the current being, previously to the operation, graduated by the piston of the coil, while the patient holds the forceps in the other hand. The current should only be sufficiently powerful to be distinctly felt. The circuit through the tooth is not made until at the instant the operation begins. The closing and breaking of the galvanic circuit is managed either by the foot of the operator or by an assistant.

A small electro-galvanic battery, arranged for this purpose, having been placed in the office of the author soon after the announcement of the discovery, he has had frequent opportunities of applying this new agent in the extraction of teeth. Thus far, about nine out of ten of those who were placed under its influence while undergoing the operation assured him that they either experienced no pain at all or only very little—not a tenth part of what they had experienced under the operation on former occasions. In almost every case in which the tooth was grasped, allowing the instrument to come in contact with only the edge of the gum, the operation appeared to be painless, or nearly so. But when pushed up a considerable distance between it and the tooth the suffering was not appreciably diminished, the electric current in such cases seeming to be too much diffused. It is stated by those who have made the experiment that this diffusion of the electric

current may be prevented by insulating the outer portion of the instrument with a coating of gutta-percha, or by japanning. The author has not tried this expedient.

How it is that the passage of an electric current through a tooth should prevent pain may be explained by supposing the subtle fluid to exhaust the sensibility of the nerves of the parts comprised in the operation ; and that it does, in a majority of cases, is attested by many who have been placed under its influence. It may be nothing more than a mere substitution of one sensation for another; but whether its application will become general, or its efficacy as an anesthetic agent be fully established, remains for future experience to settle.

The experience of the profession may be briefly summed up thus: In one-fourth the cases it relieves or neutralizes the peculiar pain of extraction, in one-half it has but little effect, and in the remaining fourth it very decidedly aggravates the pain. It has, however, the advantage over chloroform and the freezing process of being without any serious sequelæ.

"Voltaic narcotism" is a term applied by Dr. B. W. Richardson to a method of local anesthesia, in which the galvanic current is passed through a narcotic solution placed in contact with the part to be operated upon. Dr. Richardson claims that by such a method complete local anesthesia can be produced by solutions of narcotic agents which are inert when applied without the galvanic current. While this method may be used with satisfactory results in cases where the cavity of the tooth is exposed, it has never come into general use.

Dr. B. W. Richardson also introduced a much more speedy and effectual method of congelation than those before described, by taking advantage of the intense cold occasioned by the rapid evaporation of ether spray when forced through one of the instruments invented for the atomization of fluids.

"The principle," Dr. Richardson remarks, "consists in directing on a part of the body a volatile liquid, having a boiling point at or below blood heat, in a state of fine subdivision or spray, such subdivision being produced by the action of air or other gaseous substance on the volatile liquid to be dispersed. When the volatile fluid, dispersed in the form of spray, falls on the human body, it comes with force into the most minute contact with the surface upon which it strikes. As a result there is rapid evaporation of the volatile fluid, and so great an evolution of heat force from the surface of the body struck, that the blood cannot supply the equivalent loss. The part, consequently, dies for the moment, and is insensible, as in death ; but as the *vis a tergo* of the body is unaffected, the blood, as soon as the external reducing agency is withdrawn, quickly makes its way again through

the dead parts, and restoration is immediate. The extreme rapidity of the action of this deadening process is the cause of its safety."

Fig. 583 represents the apparatus, which consists of a spray-tube, bottle, and hand-bellows, for producing local anesthesia by narcotic spray.

Either absolute ether or rhigolene may be employed, both of which are highly inflammable. Some prefer rhigolene on account of its action being more prompt than that of the ether, while others consider the latter more agreeable and easily controlled. To produce the local anesthetic effect with these agents in the form of spray requires from thirty to sixty seconds. Before the application of the spray the crown of the tooth to be extracted and mucous membrane over the root should be carefully dried, otherwise a film of ice may be formed which

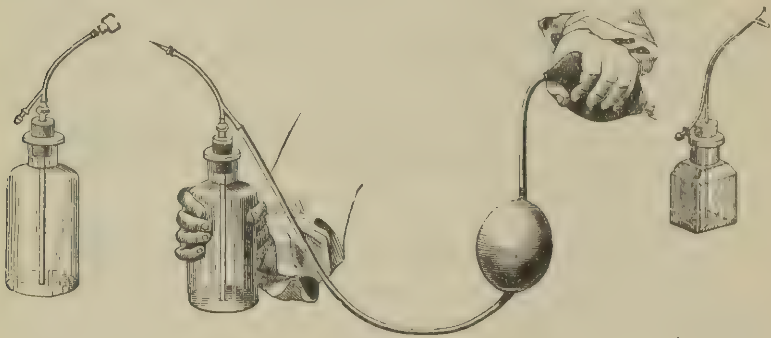


FIG. 583.

will prevent the full influence of the agent, such as is shown by the blanching of the gum.

Local blood-letting, such as follows lancing of the gums, prior to the application of the spray is said to prevent desquamation.

Obtunding mixtures, consisting of a combination of pyrethrum, aconite, chloral, veratria, and alcohol; or chloroform, aconite, belladonna, and opium, have been employed to produce local anesthesia, and in many cases with satisfactory results. For although entire insensibility to pain cannot in all cases be brought about, yet some diminution of it may be effected by the use of such agents. They have the merit, at least, of being less dangerous than the general anesthetics. Such pain-obtunding mixtures are best applied to the parts about the neck and over the root of a tooth by means of a simple apparatus devised by Von Bonhorst. It consists of two small metallic cups attached to the free ends of a spring some seven inches long, and which contain sponges to hold the liquid (Fig. 584).

When used, the sponges in the cup are saturated with the obtunding mixture and applied by pressing them on the gum on each side of the tooth to be removed, where they are retained from one-half to two minutes. Previous to the application the patient should be cautioned against swallowing any portion of the mixture.

A local anesthetic known as cocain was discovered and first applied in Germany, with astonishing and satisfactory results, in operations upon the eye. This local anesthetic has been employed with more or less satisfactory results in cases of sensitive dentine and the extirpation of the pulps of teeth by the surgical method, with satisfactory results in teeth of a loose structure. The four or five per cent. solution of hydrochlorate of cocain, may be used, a drop being applied to the sensitive surface three times, at intervals, during a period of ten or fifteen minutes; at the end of twenty-five minutes a condition of anesthesia is caused.

The unsatisfactory results from the use of cocain as a local anesthetic for the extraction of teeth, owing to the dense and impermeable character of the gum-tissues, when the agent is applied directly to the

Fig. 584.

mucous membrane, led to its application by injection with the hypodermic syringe, represented by Fig. 582, either deeply into the gum-tissues, or to a point as near as possible to the main branches of nerves supplying the teeth with sensation. For injecting the cocain deeply into the gum-tissues, the syringe, which should be an easy-working instrument, is charged with from 12 to 15 minims of a four or five per cent. solution, and the needle-point introduced through the mucous membrane, so as to inject the solution deeply into the gum-tissues around the tooth to be extracted. To reach the branches of nerves supplying the superior teeth it has been suggested to pass the needle-point of the syringe through the mucous membrane to a point as close to the infraorbital foramen as is possible, and inject about eight minims of the cocain solution; for reaching the inferior dental nerve, the needle-point is carried as near the inferior dental foramen as is possible, or, in the case of the front teeth, near to the mental foramen. Dr. Raymond recommends mixing the soluble alkaloid at the time of using it, taking care to exhaust the air from the syringe when charged ready for use, which may be done by drawing in more of the solution than

is needed, and pressing it out to the required number of minims (about eight), and then to hold the needle-point up so as to allow the air to get above the solution, when the piston should be pressed.

"The Herbst Obtundent" consists of a saturated solution of hydrochlorate of cocain in chemically pure sulphuric acid, to which a solution of sulphuric ether is added to the point of saturation, the excess of ether evaporating from the surface on which it floats. About 70 grains of the cocain hydrochlorate are required to saturate two drams of the sulphuric acid. Several applications are required to produce the anesthetic effect.

Cocain is the alkaloid of the leaves of the *Erythroxylon coca*, a shrub of South America, and has long been used by the natives of Peru and Bolivia as a nerve-stimulant. Small animals have been killed by its causing paralysis of the respiratory centers.

Other local anesthetics have recently been suggested, such as tropacocain, coryl, chlorid of ethyl, etc. (See Gorgas's *Dental Medicine.*)

Rapid Breathing as a Pain Obtunder.—The possibility of producing an anesthetic effect by rapid breathing was suggested by Dr. W. G. A. Bonwill, in 1875. By this method it is claimed that teeth may be extracted without pain. In applying it the patient should rest upon the side and in as reclining a position as is possible to operate. A handkerchief is then placed over the face to insure quiet, and directions are given to breathe rapidly at the rate of about 100 respirations per minute—blowing-out movement. At the end of from two to five minutes of such rapid breathing it is claimed that an entire, or at least partial, state of anesthesia results, which may continue for a half or for one or two minutes. This method is apparently a harmless one, but some have connected with it such a danger as venous congestion of the brain. Females appear to be more susceptible to this method than males, and children under ten years of age can rarely be induced to breathe properly.

In the case of females with a highly nervous organization it may now and then be advisable to give a temporary courage to endure pain by the administration of a teaspoonful of brandy. But there is often less trouble with delicate females than with stalwart men. The extraction of a tooth is, in the majority of cases, so simple an operation, seldom requiring more than from two to five seconds for its performance, that most persons should rather submit to it at once than have it protracted by the application of an agent for the prevention of the momentary pain which it occasions.

CHAPTER VII.

REPLANTATION, TRANSPLANTATION, AND IMPLANTATION OF TEETH.

Closely connected with the subject of extraction of teeth are Replantation and Transplantation, which appear to have been practiced several centuries ago, both in France and Germany.

Later, both of these operations attracted the attention of John Hunter, in England, and some interesting experiments were made by him in transplanting teeth, although he did not advocate the latter practice.

The operation of "replantation" consists in the return of a tooth to the same cavity from which it has been extracted, and also the necessary antiphlogistic treatment which will result in the re-establishment of the connection which originally existed between the tooth so returned and its cavity. Replantation is performed where a tooth has been accidentally removed, and also for the cure of alveolar abscess, more especially such cases where the extreme end of the root is affected with abscess, and a considerable portion of the investing membrane or periosteum is in a healthy condition. Under such circumstances the operation of replantation may be performed as follows: The tooth is to be very carefully extracted, and at once placed in warm water, to which a little tincture of iodin has been added. The cavity from which the tooth has been removed should be carefully and gently wiped out with a cone of soft Japanese paper, wrapped about the end of an excavator or other suitable instrument, to remove any shreds of the abscess sac that may remain attached to its walls, and a delicate, spear-shaped nerve instrument passed through the alveolus to detach the cyst. The cavity is then syringed with warm water and packed lightly with cotton saturated with tincture of iodin.

When this is accomplished, attention is again given to the tooth, from which all traces of the abscess sac should be removed, as well as salivary calculus, if present, care being taken, however, not to injure or remove any healthy periosteum that may remain attached to the root. The pulp chamber is then to be exposed, and, with the root canals, thoroughly cleansed and disinfected, and filled to the apex with gold or other suitable material. The packing is then carefully removed from the cavity, which is again syringed with warm water, and the tooth firmly pressed into its former position and held there for a few moments with the fingers. The mouth may then be rinsed with an astringent mouth wash and the tooth secured by ligatures, or,

with what answers better, a cap of modeling composition or gutta-percha. The mouth should be rinsed with an astringent wash three or four times daily, and be kept thoroughly clean.

The following mouth washes, from Gorgas's *Dental Medicine*, will prove useful:—

℞. Acidi carbolici (cryst.),
Glycerini and aquæ rosæ, ... āā . . . . ʒ ij. M.
SIG.—Five to eight or ten drops in a wineglass of water.

℞. Tincturæ arnicæ, ... ʒ ij
Glycerini, ... ʒ ij
Aquæ rosæ, ... ℥ ij
Aquæ destillatæ, ... ℥ x. M.
SIG.—To be used as a gargle.

Where the apex of the root of the tooth is necrosed, this portion should be excised and made smooth before the tooth is returned to its cavity, the same treatment as above described being pursued. When a replanted tooth has been returned to its cavity, the lymph present either coagulates and becomes organized, so that no pus is formed, which is the process of healing by "first intention," or the lymph may degenerate into pus, in which latter case the operation may prove a failure. To obviate such a condition, it has been suggested to make an opening through the alveolus to the apex of the root of the tooth, and, by means of floss silk or a pledget of cotton, to establish a drainage, or to insert a drain tube from the surface of the crown through the canal to the apex of the root.

The operation of "transplantation" consists in the extraction of a tooth from the mouth of one person and transferring it to a cavity in the mouth of another; in some cases the teeth of animals have been substituted for human teeth.

The defective tooth is first extracted, and having previously selected a tooth in the mouth of another, which will correspond in size, color, location, and other characteristics, it is carefully extracted and immediately transferred to the cavity from which the defective tooth has been removed, as soon as the hemorrhage has ceased. When the tooth to be transplanted is of a different form from the one it is to replace, it must be made to correspond to the new cavity by properly changing its dimensions, a procedure that would not be possible, to the same degree at least, in the case of replantation, for many examples are presented of dried teeth having been successfully transplanted. The operation of transplantation is completed by securing the new tooth in position and employing the necessary antiphlogistic treatment, as in replantation. Such teeth, however, never perfectly

harmonize with their new relation, and when a dried tooth is used its pulp canal should be previously filled with gold. It is also suggested to excise a portion of the end of the tooth, from one-sixteenth to one eighth of an inch, and to separate, by a non-conducting substance, the root filling from that in the crown, and, as in the case of replantation, to prescribe an unstimulating diet. In the operation of replantation we depend for success upon a reattachment of the peridental membrane; but in the case of transplantation, and especially where dried teeth are made use of, stability is due to absorption of the dead tissue, on the one hand, and a corresponding hypertrophy of living tissue, on the other, the root of the tooth undergoing loss of structure in the form of small cavities, and the wall of the alveolar cavity thickened by ossific deposit at points corresponding to the cavities formed in the dead tissue of the root. And while it may require one week for a replanted tooth to become firm, two or more may be necessary in the case of a transplanted tooth. For retaining replanted and transplanted teeth in position, either the modeling composition and gutta-percha splints before alluded to may be employed, or the ingenious device of Dr. Herbst, which is represented by Fig. 246 (p. 384). An interdental splint of either modeling composition or red gutta-percha, pressed while soft over the newly-placed tooth, and the teeth of both jaws brought in contact and pressed slightly into the plastic mass, will also prove effectual as a retaining appliance.

While the operation of "replantation" is a justifiable one, that of "transplantation" is objectionable for several reasons, namely: the necrosed condition of such a tooth, and, as a consequence, its uncertain duration; the liability to failure; the liability of inoculation by the transmission of disease; and the inhumanity of inflicting loss and pain on one person in order to give another a very uncertain advantage.

An operation known as "implantation" has recently been advocated by Dr. W. J. Younger. It consists in drilling artificial sockets in the maxillary bones, and inserting therein natural teeth of the proper size, shape, and shade, or at least so nearly resembling the shade of the adjoining teeth as devitalized teeth can present. Dr. Younger's method is to carefully dissect from the bone the overlying soft tissues, such as the gum and periosteum, in such a manner as to retain their connection in the form of a continuous flap, so that it may be replaced about the neck of the implanted tooth and assist in securing it. Graded trephines and burs, operated by the dental engine, are then applied to the maxillary bone, a socket drilled of the size and shape of the tooth to be implanted, which is selected prior to commencing the operation of dissecting the soft tissues.

If the tooth is a recently extracted one (although it is claimed that teeth which have been extracted months previously can be implanted), the pulp is removed and the canal filled with gold at its apex and with gutta-percha in the remaining portion. The tooth is then subjected to a solution of bichlorid of mercury, two parts to 1000 of water, at the temperature of 110° F. for some fifteen minutes. The instruments employed in the operation are immersed in the bichlorid solution, and also the root of the tooth. The artificial socket, which has been prepared in the manner above described, is then carefully cleansed with the same solution, cold water being employed to arrest the hemorrhage, and the tooth placed in position and secured by means of ligatures. The theory upon which Dr. Younger's method is based is that the natural alveolar cavity has no periosteum, and that the formation of these cavities depends upon the thin and delicate membrane lining the cells and interspaces of the osseous structure. He regards the peridental membrane as possessing no "callus generative energy except from its dental aspect;" the other side, he asserts, has the power only of forming attachment. He also claims that the vitality of the peridental membrane is kept up for many months after the extraction of the tooth, and cites examples of teeth having been successfully implanted after they had been extracted for more than a year. The failures attending the operations of replantation and transplantation he ascribes to the existence of disease at the time of treatment, a condition that does not exist when a healthy root is implanted into an artificially formed cavity in the bone.

The records of the cases of implantation, however, do not show that this operation has been to any degree more successful than those of replantation and transplantation; and the failures only prove that physiological law cannot be violated with impunity, as there are certain factors which must not be ignored. The operation of implantation is a most interesting one, as it is novel and unique, and aside from the pain experienced by the patient, one of its greatest dangers is the inoculation of disease; and this objection can also be urged against transplantation with equal force.

Figs. 585, 586, 587, and 588, represent implantation instruments for Dr. Younger's operation.

The hole in the jaw bored to that depth by the trephine is then enlarged by the reamers to fit the root which is to be implanted.

Tubular Knife No. 3 is a medium size, with which the soft tissues are cut to the bone. For the incisors and cuspids, the hole this makes corresponds fairly with the shape of the tooth at the neck. For the bicuspids, which have a more or less oblong shape on cross-section, this round hole would, apparently, not be of the correct

shape. It is only necessary, however, to have a tubular knife which measures a little less in circumference than the tooth at its neck to insure a perfect fit, for the soft tissues are elastic enough to conform to the tooth if the hole is large enough.

Spiral Knife No. 1 has two blades. In use it

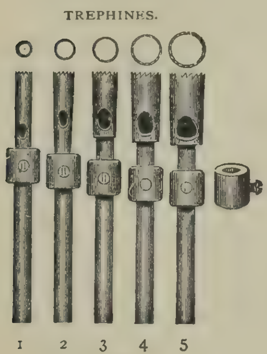


FIG. 585.

FIG. 586.

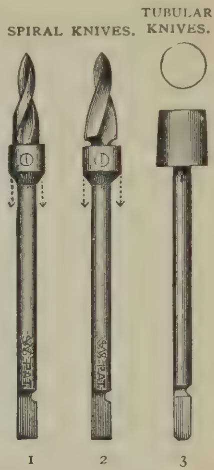


FIG. 587.

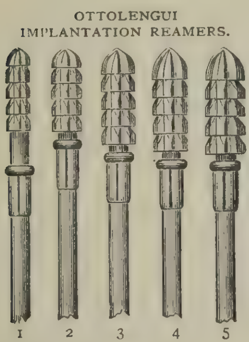


FIG. 588.

is pressed against the bone and pushed in to the shoulder, which should be adjusted to the proper position. This instrument cuts the bone with great rapidity and without any special pain.

No. 2 is a similar knife, only more conical. This is pressed into the hole previously made, and then swayed to enlarge the cavity to fit the root. It will be necessary to use this but twice, as the eye carries the shape of the root with enough accuracy to enable one to get the hole of almost the right shape the first time.

CHAPTER VIII.

DISLOCATION AND FRACTURE OF THE JAW.

FROM the peculiar manner in which the inferior maxilla is articulated to the temporal bones, it is not very liable to dislocation. When it occurs in one or both of the condyles, the luxation is always forward, the conformation of the parts preventing it from taking place in any

other direction. The oblong, rounded head of each condyle is received into the forepart of a deep fossa in the temporal bone, situated just before the meatus auditorius externus, and under the beginning of the zygomatic arch. The articular surface of each is covered with a smooth cartilage, and between them there is a movable cartilage. This latter is connected with the articulating surfaces of the condyle and glenoid cavity, externally by the external lateral ligament, internally by the capsular ligament, and in front by the tendon of the external pterygoid. This cartilage is sometimes called the meniscus, from its shape, being thickest around its circumference, especially at the back part. The temporo-maxillary articulation is strengthened by an internal, an external, and a capsular ligament, also by the tendinous and muscular insertions of the masseter, temporal, and pterygoid muscles. The intervening movable cartilage, being more closely connected with the head of the condyle than with the glenoid cavity, escapes with the former whenever dislocation of the jaw takes place.

Dislocation of the lower jaw is rarely caused by a blow, unless given when the mouth is open; it is more frequently occasioned by yawning or laughing. It has been known to occur in the extraction of teeth, and in attempting to bite a very large substance. Sir Astley Cooper mentions the case of a boy who had his jaw dislocated by suddenly putting an apple into his mouth to keep it from a playfellow.

After the jaw has been dislocated once, it is always more liable to this accident; consequently, Mr. Fox very properly recommends to those with whom it has once happened the precaution of supporting the jaw whenever the mouth is opened very widely in gaping or for the purpose of having a tooth extracted. None of these causes would be sufficient to produce the accident, unless the ligaments of the temporo-maxillary articulation are very loose and the muscles of the jaw much relaxed.

The author witnessed a case of dislocation of the lower jaw in which the displacement occurred during an attempt to extract the first right inferior molar. The patient was a young lady from Virginia, about seventeen years of age. Both condyles were luxated, but so completely were the muscles of the jaw relaxed that he immediately reduced it without the least difficulty, and afterward, by supporting the jaw with his left hand, succeeded in removing the tooth.

When the lower jaw is dislocated the mouth remains wide open, as seen in Fig. 589, and a great deal of pain is experienced; this, according to Boyer, is caused by the pressure of the condyles on the deep-seated temporal nerves and those which go to the masseter muscles, situated at the root of the zygomatic process. The condyles, having left their place of articulation, are advanced before the articular

eminences and lodged under the zygomatic arches. The jaw cannot be closed; the coronoid processes may be felt under the malar bones; the temporal, masseter, and buccinator muscles are extended; the articular cavities being empty, a hollow may be felt there; the saliva flows uninterruptedly from the mouth, and deglutition and speech are either wholly prevented or very greatly impaired. Boyer says that during the first five days after the accident the patient can neither speak nor swallow. The jaw, when only one condyle is displaced, is forced more or less to one side.

Fig. 589.

If the dislocation continues for several days or weeks, the chin gradually approaches the upper jaw, and the patient slowly recovers the functions of speech and deglutition. We are told by Mr. Samuel Cooper that it may prove fatal if it remains unreduced;* but Sir Astley Cooper says he has never known any dangerous effects to result from this accident; on the contrary, after it has continued for a considerable length of time the jaw partially recovers its motion.†

In the reduction of dislocation of the lower jaw the older surgeons employed two pieces of wood, which were introduced on each side of the mouth, between the molar teeth; while these were made to act as levers for depressing the back part of the bone, the chin was raised by means of a bandage.

The method usually adopted by modern surgeons for reducing a dislocation of this bone consists in introducing the thumbs, wrapped in a napkin or cloth (to prevent them from being hurt by the teeth), as far back upon the molars as possible; then depressing the back part of the jaw and at the same time raising the chin with the fingers. In this way the condyles are disengaged from under the zygomatic arches and made to glide back into their articular cavities. But the moment the condyles are disengaged the thumbs of the operator should be slipped outward between the teeth and the cheeks, as the action of the muscles at this instant, in drawing the jaw back, causes it to close very suddenly and with considerable force. This precaution is necessary to avoid being hurt, unless a piece of cork or soft wood has been previously placed between the teeth.

* "Surgical Dictionary," p. 306. † A. Cooper on "Dislocations," p. 389.

By the foregoing simple method the dislocation may, in almost every case, be readily reduced; but Mr. Fox mentions a case in which it failed. The subject was a lady whose lower jaw had been luxated several times before; this time the accident was occasioned by an attempt which he made to extract one of the inferior dentes sapientiæ. After having failed to reduce the luxated bone by the usual method, he "happened to recollect a statement made to him by M. de Chemant, who, having been frequently applied to by a person in Paris who was subject to this accident, had always succeeded in immediately reducing the luxation by means of a lever of wood, as recommended by Dr. Monroe." Profiting by this statement, Mr. Fox procured a piece of wood about an inch square and ten or twelve inches long. He placed one end of this upon the lower molars, and then raised the other, so that the upper teeth acted as a fulcrum. As soon as the jaw was depressed the condyle of the side upon which the wood was applied immediately slipped back into its articular cavity. The wood was then applied to the opposite side of the jaw, and the other condyle reduced in the same manner.*

The method practiced by Sir Astley Cooper consists, when both condyles are displaced, in introducing two corks behind the molars and then elevating the chin. He, however, first places his patient in a recumbent posture; † but this is seldom necessary. The reduction of the dislocation can be as conveniently effected with the patient in a sitting as in a recumbent posture.

After the reduction of the dislocation the patient is recommended to abstain for several days from the use of solid aliments and to wear a four-tailed bandage; ‡ or, what is still better, the bandage contrived by Mr. Fox (Fig. 271, p. 395), to prevent its recurrence in the extraction of teeth. When this bandage is used for the latter purpose the mouth is first opened to the proper extent, with the condyles in their articular cavities; it is then applied and the straps tightly buckled. This done, it is impossible to advance the jaw sufficiently to produce a dislocation.

FRACTURES OF THE JAWS.

Fractures of the jaws rarely occur except from direct violence. In the upper jaw this violence is usually of a character that complicates the fracture with severe injury to adjacent parts. Gunshot wounds are by far the most frequent source of fractures in this

* American edition of Fox on "The Human Teeth," p. 330.

† A. Cooper on "Dislocations," p. 391.

‡ Cooper's "Surgical Dictionary," p. 306.

locality; and it is wonderful what an amount of injury to the bones of the face may be recovered from without ill result. The bones of the face are of softer character than those found elsewhere, and consequently the whole injury is at the place of impact and along the course of the ball; no long fractures or extensive contusions are found, or very rarely so, and the parts are abundantly supplied with blood, hence the restorative process proceeds very rapidly; but this abundant sanguineous supply, so useful in the restoration of parts, is also the chief source of danger. Hemorrhage is generally excessive and difficult to control, and to secondary hemorrhage is due the greatest fatality in injuries of this kind, ligature of the carotid artery, which has been frequently practiced, usually serving but to postpone the fatal termination. Owing to the liberal supply of blood, necrosis seldom occurs, and it is seldom necessary to remove fragments of bone, even after the most extensive comminution; they should be left, except for some peculiar reason, until death is manifest in them, when they may be abstracted without additional trouble. Loosened teeth should always be left to contract adhesions, which they will generally readily do. Indeed, but little surgical interference is required in cases of this kind, and should usually be limited to efforts to secure the proper apposition of the teeth. Numerous cases of the most extraordinary injuries to the face are to be found in the surgical reports of the late war in the States, and in those of the French and English surgeons during the wars of the first Napoleon and the Crimea. Fractures of the superior maxilla may, however, occur from other violence than gunshot wounds. Mr. Salter reports a case resulting from the collision of the face and head of two "cricketers." The kick of a horse, as in the well-known Wiseman case, has occasioned frightful injury of this character. In this case the "face was driven in, the lower jaw projecting forward. . . . . The bones of the palate were driven so far back it was impossible to pass my finger behind them." The patient made a good recovery. Mr. Heath records a case reported by Dr. Tyffe, in which, "on watching the patient's profile while in the act of swallowing food, the whole of the bones of the face were observed to move up and down upon the fixed part of the skull as the different parts were brought into motion. It appeared as if the integuments only retained them in their position. It was a curious feature in the case that, notwithstanding the very extensive injury done and the violent character of the force which caused it (the upsetting of a cab), not a single tooth was fractured or misplaced. Fractures in the dentist's chair, from ill-directed efforts to remove teeth, not uncommon when "keys" were in general use, are now so infrequent as to be undeserving of special mention.

Among the complications of fracture of the upper jaw may be mentioned breaking and displacement of teeth, closure of the nasal duct with consequent epiphora, secondary hemorrhage, and paralysis of the infra-orbital nerve as the most common.

Diagnosis of fractures of the upper jaw is usually attended with but little difficulty. It is determined by pain, crepitation, irregularity in the line of the teeth, and excessive secretion of saliva. The treatment consists in the nice adaptation of the teeth and their permanent security in proper position. This is generally effected with but little difficulty, by a single finger passed into the mouth to press the fragments into position, where they may be secured by wires, or, in cases of great displacement, by the interdental splint. The hemorrhage should be controlled by styptics, of which the persulphate of iron is the best, by the actual cautery, and, when not otherwise manageable, by ligation of the carotid artery.

Fractures of the lower jaw are much more common than those of the upper. They give comparatively little trouble, are readily diagnosed, and are occasioned by direct violence, as in the upper jaw. The most common seat of fracture is the middle of the horizontal ramus. Before the use of interdental splints, fractures of the lower jaw were difficult of adjustment and were frequently attended with bad results, and in rare cases they still are so. A good many forms of apparatus have been devised, of which the simplest is the four-tailed bandage, which consists of a slip of muslin, of suitable dimensions, torn from each extremity toward the center, leaving enough space to receive the chin. It is secured by passing the tails over the top of the head and around the back of the neck, and tying them in this position. This apparatus may be supplemented by a pasteboard splint molded to the form of the jaw. Sometimes the bones are secured in position by passing wires around the firm teeth and binding them together. They may also be secured by sutures, the bones having been drilled to permit their passage. Mr. Wheelhouse, of Leeds, recommends that, after drilling through the bones on either side of the fracture, silver pins, "with flat, circular, and perforated heads," be passed through the opening from within outward, and their points bent in opposite directions so as to form hooks, and the fragments secured by passing silver or gold wire in a figure-of-eight over the pins. The perforations in the head of the wires are for silk sutures, by which they may be readily removed when necessary. It is also recommended that not only should the fragments be secured together in this way, but that they also be bound to the upper jaw. Wedges of cork cut into suitable shapes; of gutta-percha, introduced and molded to the teeth; Mutter's silver clamps, or their modification by Mr. Tomes; Hayward's silver

caps, and other more complicated apparatuses may, in our judgment, be all superseded by the vulcanite interdental splint contrived about the same time and independently of each other by the late Dr. Bean, of Baltimore, Md., and Dr. Gunning, of New York, except in cases of obstinate vertical displacement. An impression in wax is first taken of both jaws, from which a plaster cast is taken, and upon this the vulcanite plate is accurately molded with indentations corresponding exactly to the adjusted teeth, and with an interspace at the most convenient point for administering food. The splints are now introduced into the mouth, the teeth arranged in their appropriate indentations, and the whole fixed in position by a mental compress and occipito-frontal bandage, thus securing the jaws from motion and the splint from displacement. The compress consists of a light piece of wood, on which is fixed a metallic cup of form and size adapted to the patient's chin, to each extremity of which is affixed a metallic side-piece four or five inches in length and from three-quarters to one inch in width. Encasing these side-pieces are the temporal straps, made of stout cloth and secured by a strong cord at the base of each piece. The occipito-frontal bandage is composed of a band passing around the head from the forehead to the occipital protuberance behind, and secured by a buckle one inch to the right of the median line behind; of another strap secured to the band in front and behind; and a third strap extending from the temporal buckles on either side and secured to the middle strap at the point of crossing. (See Fig. 590.)

Fig. 590.

An "impromptu interdental splint," the suggestion of Professor Gorgas, and which he has employed with great satisfaction in hospital practice, both in the case of single and double fractures of the maxillæ, is described as follows:—

Taking the case of fracture of the inferior maxillary, for example, after all the parts are brought in apposition and secured by wire or silk ligatures, a partial lower mouth cup or tray, of the proper size to suit the arch, is selected. This mouth cup is of the form having an opening or cavity to allow the front teeth under other circumstances to pass through, or, what is better, is cut out in the form represented by Fig. 591 for the lower jaw and Fig. 592 for the upper jaw.

The partial lower cups with flat bottoms and square sides are more suitable than the round-bottom cups, but the latter may be used with advantage where the jaw is edentulous.

When the fractured portions are secured in position by ligatures, the cup is filled with softened modeling composition and introduced into the mouth in the same manner as when taking an impression for a partial lower set of teeth and pressed carefully into place. The opening or cavity in the front part of the cup will allow the modeling composition to press through the upper surface, and into this excess the patient is directed to bite with the superior front teeth, and the modeling composition is adapted by pressing on it with the finger to the labial surfaces of these teeth. This completes the formation of the interdental splint, which the patient is to wear until union of the fractured parts takes place. The handle of the cup, which is necessary for its introduction into the mouth, is then cut off close to the cup with a fine saw, in order that it may not inconvenience the patient by projecting beyond the lips. The openings on each side over the bicuspid and molar teeth will permit the introduction of nourishment without disturbing the appliance. A bandage is then passed over the top of the head and under the chin, and thus an easy and rapidly formed "interdental splint" is improvised, which has given satisfaction in every case where it has been applied, and permitted of removal in from three to four weeks from the time it was applied. Special splints with an adjustable handle, which may be removed by unscrewing it, have been devised by Professor Gorgas, for the treatment of fracture of both jaws, which are better adapted to the parts than the ordinary mouth cups employed for obtaining impressions in the construction of sets of artificial teeth.

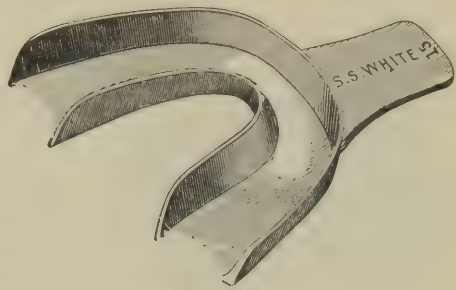


FIG. 591.

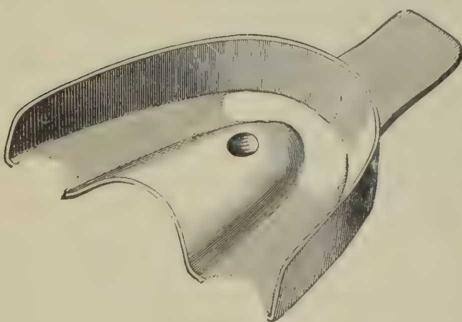


FIG. 592.

Dr. Edward H. Angle's system of treating fractures of the maxillary bones is as follows :—

"The most important consideration, after securing perfect apposition of the parts, is that they shall have uninterrupted rest, and this phase of the subject will be set forth strictly with reference to certain plans for securing fixation of the fractured maxillæ while undergoing the healing process; plans which are original with the author, and have been successfully employed in an extensive experience in the treatment of these lesions.

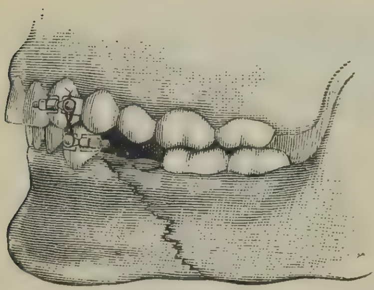


Fig. 593.

"The first plan is that of firmly and immovably holding the injured jaw in contact with the firm and uninjured jaw by means of wire ligatures wrapped in the form of the figure eight around buttons attached to bands encircling suitable opposite or nearly opposite teeth, as shown in Fig. 593.

"All the teeth are thus kept in perfect occlusion, and, as a result, the fractured ends of the bones must necessarily be in apposition, so that the conditions are most favorable to the process of repair; for it will be apparent upon reflection that no matter at what point the fracture has occurred, if the jaw contains sufficient teeth and they are placed in perfect occlusion, not only will the fracture be properly set, but the powerful muscles will be greatly relaxed and the parts be consequently freed from that tension and tendency to displacement so difficult to combat in the treatment of fractures, in the long bones especially, or in the maxillæ when the jaws are kept apart, as is necessary when the heavy interdental splints are employed.

"Indeed, we believe this plan to be a most natural and easy one, for the cusps of the teeth lock and interlace so perfectly that displacement in any direction is impossible, provided the jaws are kept closed. And in this we are further assisted by the natural contraction of the powerful muscles of mastication, it being necessary in most cases only to antagonize the anterior, feeble depressor muscles, by attachments on each side to the cuspids, or other teeth in this region, if more suitable.

"The bands, which we term fracture-bands, Fig. 594, are made very thin and strong, are adjustable, and, by means of the screw and nut, they may be firmly clamped about the teeth. Little buttons, strong and of sufficient size to admit the requisite number of wraps of the ligatures, are firmly soldered to the band. Care should always be exercised to work the band well over the crown of the tooth and down

upon the neck, then tighten the nut until the band is firmly clamped, being careful not to weaken the band by crimping or tearing. The fingers alone are usually sufficient, although a dull instrument and mallet may be used to assist in placing the band. If the teeth are crowded, a thin spatula pressed between them and allowed to remain for a few moments will provide ample space. For the ligatures, almost any of the usual materials may be employed, such as waxed floss silk, strong linen thread, or the gut ligature so extensively employed in surgery, but fine copper wire is preferable on account of its strength, pliability, and cleanliness.

FIG. 594.

"That the reader may become more familiar with this method of treatment, as well as with a few of the many modifications of which it is susceptible, reports of a few cases from practice are subjoined, with illustrations from models made accurately in each instance after treatment.

"*Case I.*—The first is represented by Fig. 595.

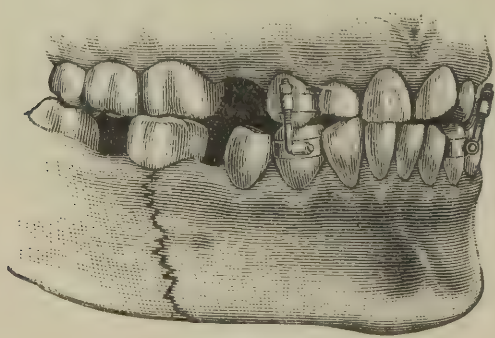


FIG. 595.

"On July 14, 1889, Wm. Fraley, aged forty-five, was admitted to the Minneapolis City Hospital. A blow from a policeman's club had produced one simple and one compound fracture of the inferior maxilla. The first was an oblique fracture on the right side, beginning with the socket of the second bicuspid, extending downward and backward, and involving the socket of the first molar. The second bicuspid had fallen out, and the first molar was much loosened. The second molar had been lost years before, while the third molar and the remaining teeth were much abraded, and much loosened by salivary calculus. The second

fracture was on the opposite side, high up in the ramus of the jaw. I could not detect the exact course the line of fracture had taken, but the crepitation of the ends of the bones, and the pain occasioned thereby, were unmistakable evidence of a fracture. The patient, as is usual in such cases, was unable to close his jaws. The parts on the right side were widely separated, and the anterior piece much depressed by reason of the action of the digastric muscle, the posterior piece of bone being drawn firmly up, and the molars occluding by reason of the contraction of the masseter muscle. He was treated as follows:—

"Bands were made to encircle all four of the cuspids (they being most firmly attached in their sockets). The fractured ends of the bones were placed in careful apposition, and the lower jaw closed, the lower teeth being correctly occluded with the upper.

"The points on the bands, where the little tubes (C, Set No. 1) shown in the engraving should be attached, were carefully noted and marked. The bands were slipped off and the tubes soldered to them, after which the bands were cemented in proper position upon the teeth, and two small traction-screws (B, Fig. 273), shown in the engraving, inserted in the tubes. The jaws were closed and the nuts tightened.

"During an attack of coughing the following night, one of the bands was loosened, but it was easily replaced the next day. No further accident or trouble occurred, the patient readily taking nourishment through the spaces between the teeth. Thus the fractured jaw was firmly supported without motion for twenty-two days, when the appliance was removed, showing most excellent results.

"That the patient was a great lover of the clay pipe is shown in the engraving by the much worn ends of the lateral incisors, which resulted from holding the stem of the pipe. While wearing the appliance he was not debarred from his favorite enjoyment, although compelled to grasp the stem between his lips instead of the teeth.

"*Case II.*—December 28, 1889, Thomas Bremen was admitted to the Dental Infirmary of the University of Minnesota, suffering from the effects of a blow received on the left side of the jaw from a cant-hook while working in a lumber camp. The result was two fractures of the jaw.

"The first fracture was on the right side, beginning between the first and second bicuspids and extending downward and backward so far as to involve the lower part of the anterior root of the first molar. The second was on the left side directly through the angle of the jaw (see Fig. 596). The accident had occurred thirty-two days previous to his admission to the infirmary, during which time nothing had been done to reduce the fracture. He reported that he had called upon a physi-

cian, who supposed the trouble was merely an abscessed tooth and had lanced the gum with a view of reducing the swelling. Later, the patient had called upon a dentist in one of the smaller towns, who also failed to diagnose the fracture, and extracted *both* bicuspids in the hope of giving relief.

"Upon examination I found considerable swelling in the region of the fracture, with the usual result: the patient being unable to close his mouth by reason of the anterior piece of the fractured bone being drawn down by the depressor muscles. A false joint had also become established, and could be easily moved without causing pain. At the fracture of the right side there was but little displacement; the swelling also was slight.

"The patient was anesthetized, and, with a view to breaking up the false attachments and stimulating activity in repair, the ends of the

FIG. 596.

bones rubbed forcibly together, placed in perfect apposition, and the jaw closed, great care being taken to articulate the teeth correctly with the upper ones. The jaw was now firmly bound in this position in the same manner as described and shown in Fig. 593, which is quite as efficient and much easier to adjust. Four bands were used, encircling the four cuspids, as shown in Fig. 596. The bands shown upon the molars in the engraving were not used, as I found them unnecessary, since the jaws were firmly supported by the anterior band alone.

"Case No. 3 is represented by Fig. 597, and is that of a healthy young Swede, twenty-two years of age, who, while washing windows, had fallen from the second story to the hard pavement. Besides receiving several minor injuries he sustained a double fracture of the lower jaw, one extending from between the central incisors, and one posterior to the second molar, the third molar having been extracted.

The right superior lateral and cuspid were knocked out, the first bicuspid broken off near the neck, and the alveolar process badly shattered. The centrals and left lateral were bent inward and forced deeper into their sockets. He had been treated by the attending physician at the City Hospital, the method employed being that of the Barton style of bandaging, with the usual result, when the bandage is employed in such cases, of aggravating the condition by forcing the pieces inward and the jaw backward.

"Upon examination three weeks after the accident, I found much displacement. The jaw was drawn backward and the right middle section of the bone tipped inward. No attention had been paid to the bent and broken condition of the superior alveoli. The teeth had become quite firm in their new but abnormal positions, and I allowed them to remain so. A fibrous attachment had been estab-

FIG. 597.

lished in the lower fracture, which admitted of considerable movement, and occasioned but little pain. There was much swelling, and pus was discharging into the mouth from the anterior fracture. I found it impossible to restore normal occlusion at that time. Bands were made to encircle the four bicuspids, and between the two lower bands, on the inside of the mouth, was placed one of the jack-screws (E and J, Set No. 1), held in place by the staple and spur (E, Fig. 286, and B, Fig. 285). The nut was tightened until the piece of bone had been tipped outward about one-half the distance to its normal position, but the operation caused so much pain that further movement was deferred. The jaws were then closed and the buttons connected by ligatures, but occlusion was far from being normal. On the next day, by again tightening the nut on the jack-screw and with

renewed ligatures bound very tightly, I was enabled to secure nearly the normal occlusion. On the third day following, by the same means, correct occlusion was established. The jack-screw was allowed to remain in position to steady the tipping section.

"The abscess was frequently syringed with fresh peroxid of hydrogen. A few fragments of bone were washed out. The fractures readily united, and on the twenty-seventh day the jaw was released and found to be quite firm.

"Case No. 4 shows another modification, and is represented by Fig. 598. A young machinist received a severe blow from the fist of an antagonist, by which two compound fractures were sustained,—one posterior to the first molar, the other in the region of the cuspid, which was involved and greatly loosened. Occlusion was established and maintained in the previously described way. Suppuration

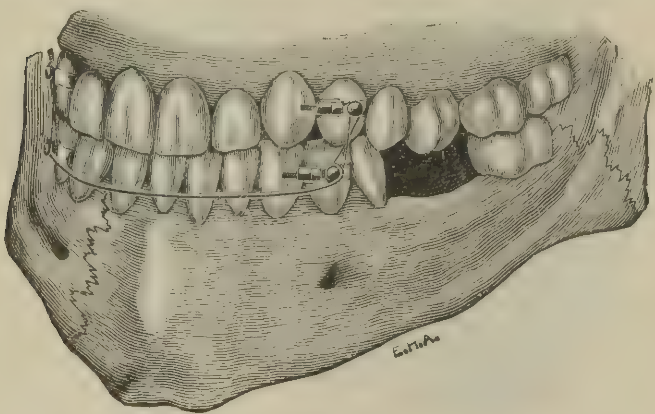


FIG. 598.

occurred in both fractures on about the tenth day, and received proper treatment. The union of the anterior fragment was slow, as the patient was troubled by a persistent, hacking cough, which occasioned a slight movement between the ends of the bone, just sufficient to interfere with the healing process. On the twentieth day the ligatures were cut, a jack-screw placed in position between the bands on the inside in the same manner as in Fig. 597, with an additional ligature firmly connecting the two buttons on the lower bands, and resting in contact with the labial surfaces of the intervening teeth. This additional support proved successful; the union proceeded slowly, and was found complete when the bands were removed on the sixty-second day after the accident.

"Another modification is shown in a somewhat peculiar case, repre-

sented in Fig. 599. The patient, a man of about forty years of age, had sustained a complete fracture of the left angle of the jaw, as the result of a kick from a horse. The jaw was enormously large and protruding, and the occlusion so unusually faulty, that I was at a loss to determine what the patient's normal occlusion was; but upon questioning him, he informed me that when a boy of ten years he had been hit with a stone, causing a fracture on the right side of the jaw, which had been allowed to heal without any treatment. This statement, with the worn facets upon the cusps of some of the teeth, and the readiness with which they occluded only at these points, showed conclusively the position in which the jaw must be secured. I at first, of course, supposed that the usual number of four bands and two ligatures would be necessary, but I found the single ligature, as shown, was quite sufficient to firmly retain the jaw in this abnormally normal

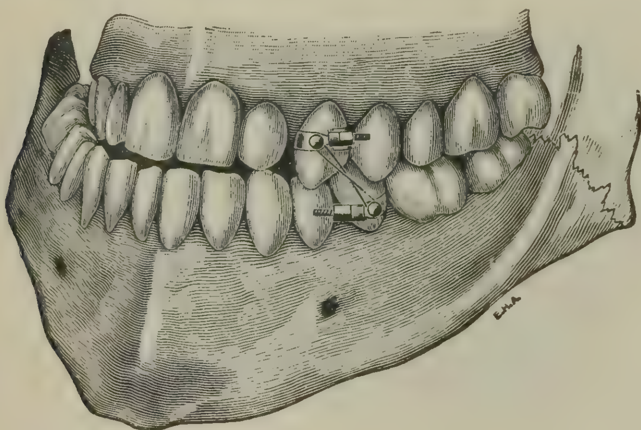


FIG. 599.

position. The jaw was set a few hours after the accident. Very little swelling ensued, the fractured parts uniting rapidly. I saw the patient but four times, and removed the bands on the twentieth day, as further support seemed unnecessary. I admonished the patient, however, to avoid using his jaw as much as possible for at least ten days thereafter.

"Fig. 600 represents a case where the patient suffered in a railroad wreck two compound fractures of the inferior maxilla, one on each side, posterior to the second molar. The left side was quite badly comminuted. The full complement of teeth was present, with the exception of the third molars. The occlusion of all the teeth was excellent. The incisors, however, were crossed (not well shown in this engraving); that is, the left superior central and lateral closed

just inside of the points of the lower incisor and cuspid, while the right central and lateral closed just outside of the points of the opposing lower cuspid, central, and lateral.

"The teeth being so perfect and the occlusion so accurate, liquid foods only were possible. The conditions were made more unfavorable on account of the patient suffering from severe spinal injury received at the time of the accident, but with the exception of considerable suppuration in the left fracture, which yielded readily to treatment, nothing unusual occurred. The ligatures were removed on the fortieth day, and excellent results were apparent.

"It might be urged against a method of treatment which involves the closure of the teeth and the binding of the jaws firmly together, that the patient would be unable to take sufficient nourishment. Experience, however, shows that this argument has practically no founda-

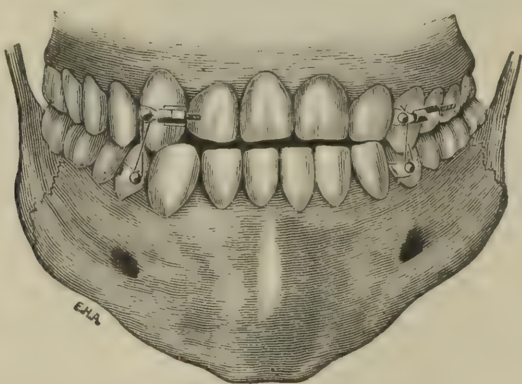


FIG. 600.

tion, for it rarely happens that a patient is found without some missing teeth, thereby providing abundant opportunity for the inception of all ordinary chopped foods, and more especially for the large number of foods now available in liquid form. Even when all the teeth are sound and in perfect position, there is plenty of space between the teeth, or behind the molars and between the upper and lower incisors, for taking all the nourishment necessary. Of course, in these rare cases more time would be required for eating. This inconvenience is very slight when we consider the advantages of freedom from an uncleanly, bulky, and inconvenient apparatus within the mouth, often accompanied by the disfigurement of bandages and splints without, as well as the great importance of the accuracy in results which it assures, so uncertain of attainment in many other methods commonly employed.

"There is also another class of lesions in the treatment of which this

plan of fixation may be employed to great advantage. I refer to excision of the lower maxilla, or those cases where a large portion of the jaw has been removed, as in Fig. 601.

"In all these cases there is a strong tendency for the remaining portion of the jaw to be drawn greatly to one side (about three-quarters of an inch, by actual measurement, in the case represented), due to the contraction of the cicatricial tissues following the healing of the wound. The plan I propose will prevent this contraction, by securing the remaining portion of the jaw in proper occlusion, by means of the fracture-bands and ligatures in the manner already described. The jaw thus firmly held will exert sufficient tension upon the healing muscles to prevent their contraction. I would also suggest the advisability of increasing the tension by the attachment of a plumper, by means of a clamp-band, to one of the molars in the upper jaw on the side from which the section has been removed, allowing the shield or plumper to extend downward and outward, to occupy somewhat the position of the missing bone. This shield may also serve a useful purpose in holding in better position the dressing of the wound.

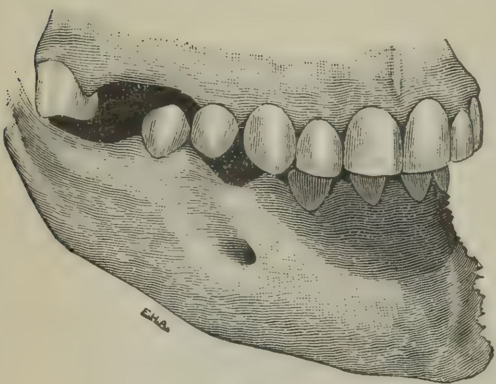


FIG. 601.

"The next plan may be said to be a modification of, or an improvement upon, the plan advocated by Hippocrates in the fifth century B. C., and which has been employed from that time to this. It consists in holding the fractured ends of the bone in apposition by wrapping ligatures about the teeth, or, as physicians now term it, wiring the teeth. The principal disadvantage has always been the slipping of the ligatures, which produced displacement

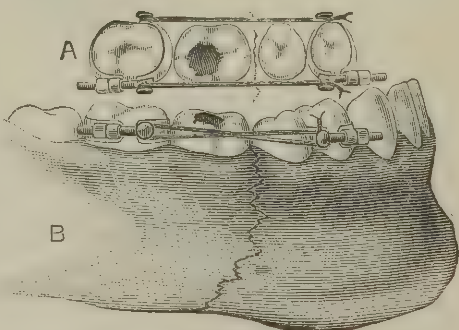


FIG. 602.

of the bones, and caused inflammation by the pressure of the sliding ligature upon the gums.

"My plan is shown in Fig. 602, and consists in encircling suitable teeth with fracture-bands and attaching ligatures to the buttons upon the bands, so that loosening of the bones or pressure upon the gums is impossible.

"A modification of the plan is shown in Fig. 603, in which additional support is secured by connecting the labial and lingual wire ligatures by loops of wire passed between the teeth, with their ends united by twisting.

"In favorable cases, as in simple transverse fractures with little or no displacement and where the teeth are very firm, if the apparatus is adjusted with skill, the plan will be found valuable, as it is very neat,

FIG. 603.

clean, and compact, and does not interfere with the freedom of the jaw.

"A few suggestions may assist the inexperienced in the adjustment of the apparatus, so that it will surely afford equal pressure and support upon the intervening teeth. The only difficulty is in regard to the proper length of the lingual ligature when completed. This is easily overcome by using two small copper wires, passing respectively above and below the buttons and extending beyond them a half-inch or more at each end. Tension is not exerted on the buttons by uniting the ends by twisting until *after* the external and transverse ligatures have been completed. The engraving is incorrect in this respect, that only one end of the lingual ligature shows union of the ends, instead of both.

Fig. 604 represents a modification of this plan used for holding in position a large section of the alveolus, including the incisors and left lower cuspids, which had been broken outward as the result of

falling from a sled while the individual was coasting with the knotted end of a rope held in the mouth. The second bicuspids were banded, and a wire ligature made to encircle the buttons and bear against the loosened teeth. The ligatures showed a slight tendency to slide down and impinge upon the gum, but this was easily remedied by encir-

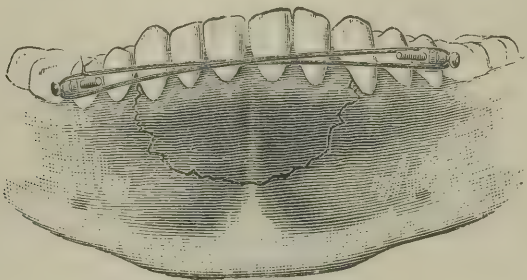


FIG. 604.

cling the main ligature and the incisors with two or three fine wire ligatures, thus giving additional support in a downward direction.

"Fig. 605 shows another plan for securing fixation which possesses several valuable features. It is a thin metal cap, swaged to fit the crowns accurately and covering a sufficient number of the teeth in the

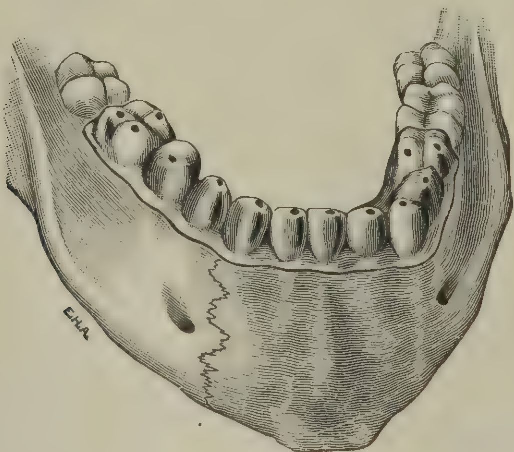


FIG. 605.

arch to afford the necessary support, the whole being firmly cemented to the teeth with oxyphosphate of zinc. Copper, gold, silver, aluminum, or vulcanite may be used; my preference is aluminum. The plan is excellent, in that it allows fredom of the jaw, is very clean, com-

pact, and retains the fractured ends of the bone firmly in apposition. Considering the simplicity of this appliance, and the familiarity of dentists with oxyphosphate of zinc, it is surprising that the value of this idea in treating fractures has not been before recognized; but I find no record of its use, although dentists frequently use similar splints in the retention of teeth after they have been regulated, and Hullihen employed a similar device in 1848 to hold the section of a jaw after a surgical operation, using ligatures to keep the appliance in place.

"For several years I supposed I had been the first to employ this method of retaining fractures, but I now believe it was first used by Dr. John H. Martindale, of Minneapolis, who preceded me a year or so, by cementing in position a splint made after Kingsley's pattern, in order to dispense with the submental cap and bandages, which

FIG. 606.

would interfere with the treatment of serious external wounds on the side of the face.

"My first case treated after this method is shown in Fig. 606. Michael P., a baker by trade, had fallen down stairs, knocking out the superior incisors, cuspids, and one bicuspid, also loosening the lower central incisors and fracturing the jaw at the symphysis. As I remember, he also received a fracture of one of the femurs. He was admitted to the Minneapolis City Hospital some time in June, 1888. I saw him first some two months after the accident occurred, during which time the attending surgeon had employed the Barton style of bandaging in treatment. Union of the bone had not taken place; on the contrary, a complete fibrous joint had been established, with the ends of the bones more or less absorbed and rounded, admitting of a free hinge movement, with pus discharging, for which a large

rubber drainage-tube had been inserted. The tube was removed, the wound thoroughly washed, and an impression taken without any attempt at changing the collapsed condition of the sides of the arch. A model was made and sawed through at the point of fracture. It was then placed in the articulator and adjusted to restore the original occlusion as nearly as possible. Over this readjusted model a very thin vulcanite splint was formed, the outlines of which corresponded to the dotted lines in the engraving.

"The first attempt at cementing it in position upon the teeth was unsuccessful, the cement hardening too rapidly, but the next proved successful. The splint remained in position without any trouble for nearly four months, when it worked loose, and we found, upon examination, that firm union had taken place.

"Of course, the range of usefulness of this splint is quite limited, as a sufficient number of firm teeth must be present on each side of the fracture. Its principal value will, I think, be found in treating fractures in the anterior part of the jaw, more especially in that class of cases resulting from gunshot wounds in which large sections of the alveolus have been carried away.

"Another plan which I have made use of in a few favorable cases with much satisfaction is shown in Fig. 607, which represents my first case treated by the method in question. On May 29, 1889, a young man of twenty-one years was admitted to the St. Anthony Hospital of Minneapolis. During an attack of epilepsy he had fallen from a lumber pile to the ground, a distance of fifteen or twenty feet. Besides receiving severe bruises, he sustained a compound fracture at the symphysis, terminating in front between the central and lateral, as shown by the line in the engraving. The fractured bone, when first seen, was quite widely separated at the top, and the left central incisor was much loosened. He was treated as follows: The ends of the fractured bones were carefully placed in position and temporarily fastened by lacing the teeth together with silk ligatures. The cuspids, being very firm, were carefully fitted with plain bands. Tubes were soldered to these bands horizontally. The large traction screw shown at A, Fig. 273, was now slipped through the tubes, and the bands were firmly cemented in position upon the teeth. The nut was then turned upon the screw until the fractured ends of the bones were

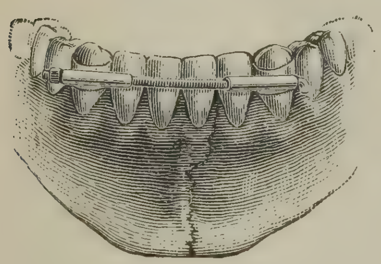


FIG. 607.

drawn snugly together. This appliance was worn without displacement or further trouble for twenty-one days, when it was removed, the bones having become firmly united.

"I may add that during the time the appliance was worn, so firmly was the jaw supported that the patient suffered but little inconvenience, and after the third day partook regularly of his meals, using his jaws freely, but of course avoiding the very hard foods.

"*Suggestions.*—In adjusting bands for the treatment of a fracture, carefully consider the direction in which to exert the proper pressure for securing the jaw. It usually happens in cases of fracture that the muscles in contracting tend not only to depress the jaw, but to draw it backward, especially if the fracture be in the region of the last molar. Consequently such teeth for anchorage should be selected as shall use pressure not only upward but forward, as in Fig. 599.

"This is only a general rule, however, but I would specially advise that the direction of force necessary in each case should be carefully considered, and then the bands and buttons be adjusted accordingly.

"Sometimes it is an advantage to band more than one tooth in order to distribute the power exactly in the direction necessary. Should any of the teeth which have been selected for anchorage show a tendency to elongation, the bands should be shifted to other teeth, or the direction of the force be changed. In but two instances have I noted this complication, and I am inclined to believe that one of the cases was due to the band slipping and impinging upon the gum, and thus probably producing the same result as when a ligature is carelessly left about the tooth.

"Should it be found advisable to employ the plan illustrated by Fig. 606 or Fig. 607 in the treatment of a case, it will sometimes be found an advantage to support the jaw by the first plan (Fig. 593), for a few days, or until the wounds are in more favorable condition for taking an impression or adjusting the apparatus.

"After the jaw has been properly set, the muscles relax in a few hours, so that the strain upon the ligature and anchor-tooth is slight.

"Very often patients receive severe bruises and internal injuries at the time the fracture is sustained, and these may occasion vomiting, more or less violent. Therefore especial caution should be observed that the securing of the jaw be delayed until all tendency to nausea has subsided. Be in no haste, for I know of no ill effects from a few hours' or even days' delay in setting a fracture. Should it be advisable to immediately set the fracture, it might be well to provide the attendant with a pair of strong scissors to cut the ligatures if symptoms of nausea develop.

"It should require but little argument to impress the importance of

extreme cleanliness about the mouth during the treatment of fractures. Frequent rinsing of the mouth with proper antiseptic solutions should be insisted upon. If the fracture is more or less comminuted, as is frequently the case, suppuration may be expected. The plan, then, which has been the most successful with me, is extra cleanliness of the wound by frequent injections of pure, fresh peroxid of hydrogen with a suitable syringe. The patient or the attendant, with a little experience, can accomplish this quite as well as the surgeon. Patience and persistence in this line will soon cause the necrotic fragments to be washed out. Only in one instance, in my experience, has it seemed necessary to interfere with the wound by scraping the bone with instruments.

"While the patient is undergoing treatment, his general health should also not be allowed to become impaired. Plenty of exercise in the open air, if other injuries do not prevent, should be insisted upon, as well as a requisite amount of nourishing food, and the surgeon should occasionally inspect the bands and ligatures to see that they are in order, so that the jaw shall not be allowed to get loose, admitting movement between the fractured ends of the bones. Should one of the bands become broken, it should be replaced as quickly as possible. No special harm will come from cutting the ligatures and separating the jaws for the purpose of replacing it.

"In cases where a section of the bone shows a tendency to lean, so that the teeth do not properly occlude, a finger of metal, made to bear against a tooth in the leaning section and soldered to a band encircling some favorably located anchor-tooth, will effectually restore the proper occlusion.

"In like manner the range of application of this method of retaining fractures may be extended to cases where fractures occur in the body of the bone and the molars are absent. The edentulous portion of the jaw may be securely held in proper position by a prop made to bear against the section of bone, and kept in place by attachment to a band secured about one of the molars or bicuspids in the upper jaw.

"The methods so far offered will, I believe, nearly cover the entire range of cases requiring treatment. There still remains, however, one distinct class for consideration, namely: the edentulous patient. Fortunately, patients of this class requiring treatment are exceedingly rare, and probably the best plan is the Gunning splint, or what is the same in principle, attaching together by wire or vulcanite the artificial dentures, should the patient possess them.

"The cases of fractures so far described have been confined to the inferior maxilla. The methods, however, of securing fixation are all more or less applicable to the treatment of fractures in the upper jaw

as well, though I believe the one first described is most applicable ; for the reason that, if one of the superior maxillary bones is fractured, it will be more or less displaced and usually forced downward. After carefully replacing the pieces, the jaws are closed and the teeth articulated, and the pieces thus supported and held upward in position by the lower jaw secured in the usual way by bands, buttons, and ligatures, attached on the uninjured side.

"Finally, as all the apparatus possessing any special merit in the treatment of fractures of the maxillæ have been invented by dentists, and their familiarity with the parts, special knowledge of mechanics, and facilities at their command fit them above all other surgeons for this work, I would recommend that the different dental societies throughout the country shall secure appointments of competent dentists in all hospitals for the treatment of these lesions. for to them this special line of surgery justly belongs."

CHAPTER IX.

DISEASES OF THE ANTRUM.

THE cavity known as the antrum of Highmore, or maxillary sinus, is situated in the body of the superior maxillary bones, on either side of the nose and beneath the orbit of the eye. It is an irregular cavity, varying in size in nearly every superior maxillary bone, and often divided into several parts by vertical partitions (septi) of bone, an observation of many bones being necessary to show its extent and general form. The alveolar process immediately over the ends of the roots of the first and second superior molars and bicuspids forms the floor of the antrum ; hence it is readily seen how abscesses of the roots of these teeth may involve this cavity.

One of the nasal openings of the antrum, of which there are two in the middle meatus of the nose, when in a normal condition, is very nearly closed by a duplicature of the membrane lining the turbinated and other adjoining bones, and secretions may readily accumulate when this outlet into the nose is closed by congestion of the membrane, giving rise to serious symptoms, such as disfigurement, pain, etc. The other opening is very small, and can only be entered with the point of a probe. The mucous membrane which lines the nares passes through these openings into the antrum, and lines this cavity also.

The antrum is subject to some of the most formidable and danger-

ous diseases the medical or surgical practitioner is ever called upon to treat; and yet there are few diseases incident to the human body that have received less attention from writers on pathology and therapeutics than these. There are diseases here met with over which neither the surgeon nor physician can exercise any control, the progress of which ceases only with the life of the unfortunate sufferer.

All of the diseases to which the maxillary antrum is subject, however, are not of so dangerous a character, for some are very simple and easily cured; but even those which are regarded as the least dangerous, and which yield most readily to treatment when instituted during their incipient or earlier stages, may assume, if neglected or improperly treated, a form so aggravated as to bid defiance to the skill both of the physician and surgeon. While thus, on the one hand, the most simple affections of this cavity may, by neglect or improper treatment, become ultimately incurable, many of those, on the other hand, which are considered the most malignant and dangerous, might, we have no doubt, by timely and judicious treatment, be effectually and radically removed.

The form which the disease puts on is determined by the state of the constitutional health or some specific tendency of the general system; and we can readily imagine that a cause which, in one person, would give rise to simple inflammation of the lining membrane, or mucous engorgement of the sinus, would in another produce an ill conditioned ulcer, fungus hematodes, or osteo-sarcoma. Simple inflammation and mucous engorgement not unfrequently causes caries and exfoliation of the surrounding osseous tissues, and, in some instances, even the destruction of the life of the patient.

The importance of early attention to the diseases of this cavity is, therefore, very apparent; and this is the more necessary as it is often difficult and sometimes impossible to determine the character of the malady until it has progressed so far as to involve, to a greater or less extent, the neighboring parts, when, if it has not become incurable, its removal is, to say the least, rendered less easy of accomplishment. It may be safely assumed, therefore, that in a very large majority of the cases of diseases of the maxillary sinus, the danger to be apprehended arises more from neglect than from any necessarily fatal character of the malady, so that in forming a prognosis, the circumstances to be considered are the state of the constitutional health, the progress made by the affection, and the nature of the injury inflicted by it upon the surrounding tissues. If the general health is not so much impaired as to prevent its restoration by the employment of proper remedies, and the neighboring structures have not become implicated, the prognosis will be favorable; but if the functional operations

of the body have become very much deranged, and the bones of the face and nose seriously affected, the combined resources both of medicine and surgery will prove unavailing.

In young and middle-aged subjects of good constitution, a morbid action may exist in the antrum for years without giving rise to any alarming symptoms, while the same affection in another less healthy might rapidly extend and degenerate into a form of disease so malignant as to threaten the speedy destruction of the life of the patient. Medical history abounds with examples of this kind, and conclusively establishes the fact that the state of the general health and habit of body, whatever may have been the primitive characteristics of the malady, ultimately determines its malignancy; in the treatment of affections of this cavity, therefore, as well as of other local diseases of the body, the condition of the system should not be overlooked.

Independently of the danger arising from the local affection, diseases of the antrum are, for the most part, very loathsome, and subject the patient to great annoyance. They change the quality of its secretions, and cause them to exhale a fetid, nauseating odor. This, in many instances, is almost insufferable to the patient, and when they are prevented from escaping through the natural opening into the nose, they pass through one artificially formed by the surgeon, or made by the disease through the cheek, alveolar border, or palatine arch, always causing the patient great inconvenience.

The progress of disease in this cavity is often very insidious. It not unfrequently happens that it exists for weeks and even months before its presence is suspected. The slight uneasiness felt is attributed to some morbid condition of the teeth or gums, and the symptoms attendant upon one description of affection are often so similar to those that accompany another, that it is impossible to determine its true character until it has made considerable progress.

The morbid affections of the maxillary sinus are, for the most part, similar to those of the nasal fossæ.

The most simple form of disease that occurs here is inflammation of the lining membrane, and this, in most instances, may be said to precede all others. It often subsides spontaneously; but when it continues for a long time it is apt to become chronic, and may then give rise to other and more formidable kinds of disease. When unattended by any other morbid affection, either local or constitutional, it is easily cured.

A purulent condition of the fluids of the antrum is a common affection, but is seldom met with in persons of good constitution. It seems to be dependent upon a bad habit of the body; also upon inflammation of the mucous membrane of the sinus, which arises

more frequently from dental irritation than any other cause. This condition of the secretions sometimes gives rise to caries and exfoliation of portions of the surrounding bone and to fistulous ulcers; but when dependent upon no other local cause than simple inflammation of mucous membrane, it is seldom that such effects result from it. When complicated with other morbid conditions of the cavity they are not infrequent.

Ulceration of the lining membrane is an affection less frequently met with. It is rarely, if ever, idiopathic, but seems rather to be dependent upon some other local malady or some specific constitutional vice. Scorbutic and scrofulous diatheses, and those affected with a venereal taint, are more liable to ulceration of this membrane than persons of sound constitution. Consequently, it is seldom cured by local remedies alone. It is almost always complicated with fungus of the membrane and caries of the walls of the sinus, and may, if neglected, take on a cancerous form and become incurable.

The next form of disease is caries of the antral parietes. This, though always complicated with other forms of diseased action, seems, nevertheless, to be worthy of separate consideration. Like ulceration of the lining membrane, it is the result of some other affection. It may result from accumulation of the secretions of the sinus, from ulceration, or from tumors.

The occurrence of fungus or polypus and of various kinds of tumor is less frequent than any of the preceding affections; yet this cavity is not exempt from them, and they constitute the most dangerous form of disease to which the superior maxilla is subject. Although it is probable that in their incipient stage they might in nearly every instance be radically removed, it is seldom they are cured after they have attained a very large size, and have implicated to a considerable extent the surrounding tissues. They have, however, been successfully extirpated even after they had acquired great volume, and implicated to such an extent the surrounding parts as to render necessary the removal of the whole of the superior maxillary bone. They usually grow with great rapidity, and if not completely removed are soon reproduced.

Besides these, other varieties of disease are occasionally met with here. The antrum is liable to injuries from blows and other kinds of mechanical violence, and from the introduction of insects and foreign bodies. The diseases of the maxillary sinus are supposed to be dependent upon certain specific constitutional vices; upon the obliteration of the opening of this cavity into the nose, and upon dental irritation. That all of these may at times be concerned in their production is more than probable. But actual disease rarely develops itself spontaneously as a consequence merely of a bad habit of body or constitu-

tional vice. This does not of itself originate disease, but only occasions an increase of susceptibility of the tissues to morbid impressions; so that when an unhealthy action is once induced here, a more aggravated or a different form of disease occurs than that which would otherwise have been produced.

Thus it may be seen that disease of the maxillary sinus is dependent upon some exciting cause, favored by some constitutional vice; for without this no serious morbid effects would be produced, or if produced, they would be of a different or less aggravated character. Any disposition or vice of body which weakens the vital energies of the system increases the susceptibility, or rather *excitability*, of all its parts—those of this cavity equally with the rest. There are various kinds which have this effect; as, for example, the scorbutic, scrofulous, venereal, mercurial, etc., each of which may influence the character of the morbid action in a manner peculiar to itself; or it may be similar to that which might be exercised by another, only causing it to assume a greater or less degree of malignancy, accordingly as the functional operations of the body generally are more or less enervated by it.

This seems to be the way in which a bad habit of body is capable of affecting the maxillary sinus. It is a predisposing, but not an exciting cause of disease; and it is important that this distinction should be borne in mind. The one should never be confounded with the other, because an error of this sort might, in many instances, lead to the adoption of incorrect views concerning the therapeutical indications of the disease. This part of the subject we shall have occasion to advert to hereafter.

Inflammation and ulceration of the nasal pituitary membrane sometimes extend themselves to the maxillary sinus; but disease is not so frequently propagated from the nasal fossæ to this cavity as the intimate relationship between the two might lead one to suppose. It is seldom that both are affected at the same time. Hence, we infer that although lined by one common membrane, the propagation of disease from one to the other is a rare occurrence.

The obliteration of the nasal opening of this cavity is sometimes caused by disease in the nose, and is followed by mucous engorgement of the sinus, inflammation of the lining membrane, distention of the osseous walls, and not unfrequently by other and more complicated forms of disease. But the closing of this opening is oftener an effect than a cause of disease in this cavity, and it generally re establishes itself without any assistance of art after the cure of the affection which caused it.

If all the circumstances connected with the history of the diseases under consideration could be ascertained, we think it would be found

that these affections are more frequently induced by a morbid condition of the teeth, gums, and alveolar processes than any other cause. There are, in fact, no sources of irritation to which this cavity is so much and so often exposed as those arising from dental organism. It is separated from the apices of the roots of the superior molars and bicuspids by only a very thin plate of bone, and is sometimes even penetrated by them; so that it could scarcely be otherwise than that aggravated and protracted disease in the teeth and alveoli should exert an unhealthy influence upon it. The pain occasioned by diseased teeth is often very severe, sometimes almost excruciating, and inflammation in the alveolo-dental periosteum and gums frequently extends itself to the whole of one side of the face. It would hardly be possible, therefore, for this cavity to escape. Alveolar abscess and sometimes necrosis and exfoliation of the socket of the affected tooth arise from the inflammation thus lighted up. It often happens that the gums and alveolar periosteum are affected for years with chronic inflammation and other morbid conditions.

If, in addition to these facts, other proofs be necessary to establish the agency of dental and alveolar irritation in the production of disease in the maxillary sinus, they may be found. Many of the affections here met with are often cured by the removal of diseased teeth after other remedies have been employed in vain, and that without even perforating the antrum. This would not be the case if the irritation did not arise as a consequence of the dental malady.

Inflammation of the Lining Membrane of the Maxillary Sinus.—Inflammation, when not complicated with any other morbid affection, is the most simple form of disease to which the pituitary membrane of the antrum is subject. As it precedes and accompanies all others, it will be proper to offer a few remarks upon it before entering upon the consideration of those of a more aggravated nature.

Inaccessible as it is here to most of the acrid and irritating agents to which it is exposed in the nasal fossæ and some other cavities of the body, it would rarely become the seat of inflammation were it not for its proximity to the teeth and alveolar border; and simple inflammation rarely gives rise to any other form of diseased action, unless favored by some general morbid tendency, but usually subsides spontaneously on the removal of the exciting cause. In good constitutions it is less subject to inflammation, and consequently to any other description of morbid action, than those in whom there exists some vice of body or constitutional predisposition. Febrile and gastric affections, eruptive diseases, such as measles, smallpox, etc., syphilis, and excessive and protracted use of mercurial medicines, a scorbutic or scrofulous diathesis of the general system—in short, everything that has

a tendency to enervate the vital powers of the body, increases its irritability.

When in a healthy condition it secretes a slightly viscid, transparent, and inodorous fluid, by which it is constantly lubricated ; but inflammation changes the character of the secretion. It causes it to become vitiated ; at first less abundant, it is afterward secreted in larger quantities than usual, becomes more serous, and so acrid as sometimes to irritate the membrane of the nose, over which it passes after having escaped from the antrum. It also exhales an odor more or less offensive, accordingly as the inflammation is mild or severe. It moreover gives rise to a thickening of a membrane, and sometimes to obliteration of the nasal opening. This last rarely occurs, but when it does happen an accumulation of the secretion and other morbid phenomena, of which we shall hereafter treat, result as a necessary consequence.

If at any time during the continuance of the inflammation the patient is attacked with severe constitutional disease, the local affection will be aggravated and sometimes assume a different character.

The inflammation, when long continued, degenerates into a chronic form, and is sometimes kept up for several years without giving rise to any other unpleasant symptoms than occasional paroxysms of dull and seemingly deep-seated pain in the face and a vitiated condition of the fluids of this cavity. The slightly fetid odor which they exhale ceases to be annoying or even perceptible to the patient when he becomes accustomed to it.

Symptoms.—The symptoms of inflammation here, though not always precisely the same as elsewhere, are, for the most part, very similar. They are severe, fixed, and deep-seated pain under the cheek, extending from the alveolar border to the lower part of the orbit ; local heat, pulsation, and sometimes fever. Boyer says these symptoms are not always present, and that inflammation may exist when it is not expected. Other affections of the face and superior maxilla may be mistaken for this, and this for others ; but that inflammation should exist without being attended with pain or any other signs indicative of its presence, is scarcely probable.

Deschamps distinguishes the symptoms of this from those of other affections of this cavity by a dull, heavy pain in the region of the sinus, which, he says, becomes sharp and lancinating and extends from the alveolar arch to the frontal sinus. The disease goes on without interruption, increasing until the superior maxilla of the affected side is more or less involved. This malady, he says, cannot be confounded with any other, even where there is no external visible cause ; differing from a simple retention of mucus by being painful at the commencement, and by not being accompanied with swelling of the bones ; from

polypus, by the continuance of pain; and from cancer, by the character of the pain. "Suppuration and ulcers have peculiar signs which cannot be confounded with those of inflammation." Pain in the molar and bicuspid teeth, accompanied by a sense of fluctation in the parts, he seems to regard as a very certain indication of inflammation, and especially when joined to the other symptoms. "If an external cause is discovered, it will furnish a certain diagnosis;" he also mentions fever and headache as almost invariable accompaniments.

The inflammation, if not subdued by appropriate remedies, after having continued for a length of time, gradually assumes a chronic form; the pain then begins to diminish and is less constant; it becomes duller and is principally confined to the region of the antrum. The teeth of the affected side cease to ache, or ache only at times, but still remain sensitive to the touch. The mucous membrane of the nostril next the diseased sinus is often tender and slightly inflamed; and if in the morning, or after two or three hours' sleep, the other nostril be closed by pressing upon it with the thumb or one of the fingers, and a violent expiration be made, a thin, watery fluid of a slightly fetid odor will be discharged, and pain will be experienced in the region of this cavity.

Causes.—All morbid conditions of the teeth and gums, causing irritation in the alveolar periosteal tissue, may be regarded as among the most frequent of its exciting causes, especially caries, necrosis, and exostosis; also loose teeth, and the roots of such as have been either fractured in an attempt at extraction, or by a blow or fall, and left in their sockets, or that have remained after the destruction of their crowns by decay. It sometimes happens, too, that inflammation is excited in this membrane by fractured alveoli; but when an accident of this sort occurs the detached portions of bone are generally soon thrown off by the economy, and, the cause being removed, the inflammation immediately subsides. Not so with the roots of the teeth. They often remain concealed in their sockets for years, unless removed by art. Nature, it is true, makes an effort to expel them from the jaw, but this is accomplished only by a slow and very tedious process, and not, in many instances, until they have given rise to some serious affection. But of the deleterious effects that result from necrosed roots of teeth in the alveoli it is not necessary now to speak; as extraneous bodies, they are always productive of more or less irritation. We might also mention exposure to sudden transitions of temperature and certain constitutional diseases as among the causes which occasionally give rise to inflammation of this membrane.

Treatment.—The curative indications of inflammation of the lining membrane of the antrum are simple, and, for the most part, similar

to those of inflammation in other parts of the body. In many cases great benefit will be derived from the application of leeches to the cheek, as recommended by Mr. Thomas Bell. When the disease is dependent, as in most cases it is, upon an unhealthy condition of the alveolar processes, the first thing to be done is to remove all such teeth or roots of teeth as are productive of the least irritation; for, while any local sources of irritation are permitted to remain, neither topical nor general bleeding, or, indeed, any other treatment, will be of permanent advantage.

Simple inflammation of the lining membrane of the antrum would be of little consequence were it not that it is liable to give rise to other and more dangerous forms of disease, such, for instance, as engorgement or a purulent condition of its secretions. It should never, therefore, be permitted to continue, but be as speedily arrested as possible; and for the accomplishment of this the means here pointed out will, if timely and properly applied, be found fully adequate.

Purulent Condition of the Secretions and Engorgement of the Antrum.—A purulent condition of the secretions of the antrum and mucous engorgement are indiscriminately, though very improperly, denominated by many writers on the affections of this cavity, abscess. To this neither bears the slightest resemblance.

There is no doubt that a purulent condition of the fluids of this cavity is often complicated with ulceration of the lining membrane; but that the affection is different from abscess, its very nature and situation are sufficient to show.

When complicated with ulceration of the mucous membrane—and it is probable that a purulent condition of its secretions, in most instances, is thus complicated—the affection is analogous to ozena, and many of the older writers designate it by that name. Mr. Bell describes it, and very properly, too, as being similar to gonorrhea; both diseases alike consist in an alteration of secretion; in the one case of the pituitary membrane, and in the other of the mucous lining of the urethra; but in neither instance does it possess any of the characteristics of abscess, though the matter in both is purulent.

It has been before stated that the obliteration of the nasal opening was more frequently an effect than a cause of disease in the maxillary sinus; it does, however, sometimes become closed from other causes than an unhealthy condition of this cavity; when this happens, engorgement of the sinus is the inevitable consequence. The fluids thus accumulated are not always at first purulent, although they may subsequently become so; when the closing of the opening is the result of previous disease in the antrum, the secretions are more or less altered from the very first.

Accumulation of any secretion within the antrum, whether of mucus or pus, is a source of irritation to the lining membrane, and the pressure which it ultimately exerts upon the surrounding walls causes a new form of diseased action, which not unfrequently involves in disease all the bones of the face as well as those of the base of the cranium. When prevented from escaping through the nasal opening, the secretion eventually makes for itself a way of escape—sometimes through the cheek; at other times beneath it, just above the alveolar ridge; or through the palatine arch or alveoli by the sides of the roots of one or more of the teeth; and from a fistula thus established, fetid matter will be almost constantly discharged. From openings of this sort the matter is sometimes discharged for years, while the disease in the antrum, very frequently, does not seem to undergo any apparent change. At other times the membrane ulcerates and the bony walls become carious.

A purulent secretion from the mucous membrane of this cavity, independently of caries of the bone, or even of simple fistulous openings, is an exceedingly troublesome and unpleasant affection. The odor from the matter is often very annoying, even to the patient, and when the secretions are retained for some days in the sinus before they escape, the fetor is almost insufferable.

In good constitutions the secretions of the antrum are not so liable to become purulent, though they be confined for a long time in the cavity, and thus become more or less offensive. Inflammation of the lining membrane (the immediate or proximate cause) may exist for years without giving rise to it. It is only in scrofulous, scorbutic, or debilitated habits that they are liable to become thus altered. The difference in the effects produced upon them and the surrounding parts by inflammation, is owing to the difference in the state of the constitutional health of those affected with it.

Where a puriform state of the secretions is complicated with ulceration of the membrane, the matter will have mixed with it a greater or less quantity of flocculi, sometimes of so firm a consistence as to block up the nasal opening and prevent its exit. Mr. Thomas Bell says he has seen more than one case in which a considerable accumulation had taken place in the antrum, accompanied by the usual indication of this affection (muco-purulent engorgement of the sinus), when a sudden discharge of the contents into the nose took place, "in consequence of the pressure having overcome the resistance which had thus been offered to its escape." Cases of a very similar nature have fallen under our observation, the history of one of which will be given in the course of this chapter. The formation of these flocculi rarely ceases, except with the cure of the ulcers on the membrane. They give rise to considerable irritation, and their presence always

constitutes an obstacle to the cure. They are usually removed by injections.

The pituitary membrane of the antrum, when in a healthy state, secretes, as we have before stated, a transparent, slightly viscid, and inodorous fluid, poured out only in sufficient quantity to lubricate the cavity. But when inflammation is excited in the membrane, its secretions soon become more abundant, and are at first thinner, afterward thicker and more glutinous. Their color and consistence are not always the same: instead of being transparent, they sometimes have a dirty, opaque appearance; at other times they assume a greenish, whitish, or yellowish color, and in some instances they bear a considerable resemblance to pus, which, it has been conjectured, might be owing to suppuration of some of the mucous follicles and a mixture of pus with its secretions. Mr. Thomas Bell, however, inclines to the opinion that it is attributable to an "alteration simply" of the secretions of the cavity. Their color and consistence are determined by the degree of inflammation; the length of time it has existed; the state of the health of the lining membrane, and that of the surrounding osseous walls; the egress which the matter has from the sinus; and the general habit of the body.

Affections of this sort are more common to young subjects than to middle-aged or persons in advanced life. An eminent French writer says that of three individuals affected with dropsy (mucous engorgement), the oldest was not twenty years of age.

Symptoms.—The diagnoses of the several affections of the antrum are so much alike, that it is often difficult to distinguish those that belong to one from those attendant upon another. The symptoms of mucous engorgement and purulent accumulation, however, are generally such as will enable the practitioner to distinguish, with considerable certainty, these from other affections. They are always preceded by inflammation of the lining membrane; a description of the symptoms of which, having already been given, need not be repeated. Omitting these, we at once proceed to mention those by which they are accompanied.

In speaking of the symptoms more particularly belonging to a purulent condition of the secretions of the antrum, Deschamps says the affection may be distinguished by dull, heavy pain, extending along the alveolar border. Upon this symptom alone little reliance can be placed, as it is always present in chronic inflammation. In addition to this he mentions the presence of decayed teeth; soreness in those that are sound; and, on the patient's inclining his head to the side opposite to the one affected, the discharge of fetid matter from the nose. These are very conclusive indications of purulent

effusions in this cavity. Bordenave, after enumerating the symptoms indicative of inflammation, mentions the following as belonging to the affection of which we are now speaking: dull and constant pain in the sinus, extending from the maxillary fossæ to the orbit; a discharge of fetid matter from the nose, when the patient inclines his head to the opposite side, or when the nose is blown from the nostril of the affected side. These symptoms are mentioned by almost every writer upon the subject, as indicative of a purulent condition of the secretions of the maxillary sinus.

The symptoms of engorgement differ materially from those which denote simply a purulent condition of the mucous secretions. The pain, instead of being dull and heavy, as just described, becomes acute, and a distressing sense of fullness and weight is felt in the cheek, accompanied by redness and tumefaction of the integument covering the antrum. The nasal opening having become closed, the fluids of the cavity gradually accumulate until they fill it; when, finding no egress, they press upon and distend the surrounding osseous walls, causing those parts which are the thinnest ultimately to give way. The effects are generally first observable anteriorly beneath the malar prominence, where a smooth, hard tumor presents itself, covered with the mucous membrane of the mouth. But this is not always the point which first gives way; the sinus sometimes bursts into the orbit, at other times outwardly through the cheek, or through the palatine arch. The long-continued pressure thus exerted upon the bony walls often causes the breaking down or softening of their tissues.

The tumor, which is at first hard, becomes in a short time so soft as readily to yield to pressure. A distention, Deschamps says, may be distinguished from other diseases that affect the skin or subcutaneous tissues by the uniformity or regularity of the tumor, its firmness at the commencement, the slowness with which it progresses, and, above all, by the natural appearance of the skin, and the absence of pain when pressure is made upon the tumor. Obliteration of the nasal opening, he says, may be suspected by the dryness of the nostril of the affected side, the mucous membrane of which becomes thickened and the cavity contracted, inflammation and sponginess of the gums, loosening and, sometimes, in consequence of the destruction of their sockets, displacement of the teeth, may also be mentioned as occasional accompaniments of engorgement.

Causes.—Inflammation of the mucous membrane is the cause of a purulent condition of the secretions of the maxillary sinus, and this arises more frequently from peridental irritation than from any particular habit of body or constitutional disturbance. Engorgement results from the obliteration of the nasal opening, which, in the case of

altered secretion, is usually caused by inflammation and thickening of the lining membrane.

Treatment.—The curative indications of muco-purulent secretion and engorgement of the maxillary sinus are, firstly, if the nasal opening be closed, the evacuation of the retained matter; secondly, the removal of all local and exciting causes of irritation ; thirdly, and lastly, the restoration of the lining membrane to its normal function.

For the fulfillment of the first an opening must be made into the antrum, and this should be effected in that part which will afford the most easy exit to the retained matter. Several ways have been proposed for the accomplishment of this object ; and before we proceed further, it may not be amiss to notice some of the various methods that have been adopted by different practitioners.

With regard to the tooth most proper to be extracted, authors differ. Cheselden preferred the first or second molar. Junker recommended the extraction of the first or second bicuspid, and if a fistula had formed, to enlarge it instead of perforating the floor of the antrum. But the second molar, being directly beneath the most dependent part of the cavity, is the most suitable tooth to be removed. If this be sound, the first or third molar, or either of the bicuspids, if carious, may be extracted in its stead, and, in fact, no tooth beneath the antrum in an unhealthy condition should be permitted to remain. Heath recommends the extraction of the first molar on account of the depth of its socket, and because it is more liable to decay than any of the other teeth.

An opening having been effected through the palatine cavity of a molar tooth into the antrum, it should be kept open until the health of the cavity is restored. For this purpose, a sound, bougie, or cannula adapted to the purpose may be introduced.

When the natural opening is closed, the first indication, as has been stated, is the evacuation of the matter; and for this purpose a perforation should be made into the sinus, and the most proper place for effecting this, it has been shown, is through the alveolar cavity of the second molar. It may, however, be penetrated from that of either of the other molars or bicuspids.

The perforation, after the extraction of the tooth, is made with a straight trocar, which will be found more convenient than those usually employed for the purpose. The point of the instrument, having been introduced into the alveolus through which it is intended to make the opening, should be pressed against the bottom of the cavity in the direction toward the center of the antrum. A few rotary motions of the instrument will suffice to pierce the intervening plate of bone.

Fig. 608 represents trephines for opening the antrum, either through the palatine cavity of a second or first molar, or through the alveolus between these two teeth.

If the first opening be not sufficiently large, its dimensions may be increased to the necessary size by means of a spear-pointed instrument. The entrance is usually attended with a momentary severe pain, and the withdrawal of the instrument followed by a sudden gush of fetid mucus. In introducing the trocar, care should be taken to prevent a too sudden entrance of the instrument into the cavity. Without this precaution it might be suddenly forced against the opposite wall. It is not always necessary to perforate the floor of the antrum after the extraction of the tooth; it occasionally happens, as has already been remarked, that some of the alveolar cavities communicate with it.

Fig. 608.

An opening having thus been effected, it should be prevented from closing until a healthy action is established in the lining membrane, and for this purpose a bougie, or leaden or silver cannula, or, still better, a small metal plate, fitted by impression and dies to the portion of the ridge about the opening, with a small tube attached to fill the aperture, to facilitate the flow of matter, and for syringing, and as preventive of the premature closure of the opening, may be inserted and secured to one of the adjacent teeth. It should, however, be removed for the evacuation of the secretions at least twice a day. The formation of an opening at the base or most dependent part of the sinus will, in those cases where a fistula has been previously formed, be followed in most instances by speedy restoration. Having proceeded thus far, the cure will be aided by the employment of such general remedies as may be indicated by the state of the general health; and for the dispersion of the local inflammation, leeches to the gums and cheeks will be found serviceable. The antrum may, in the meantime, be injected with, at first, some mild or bland fluid, and afterward with gently stimulating liquids. Diluted port wine, weak solutions of the sulphate of zinc and rose-water, sulphate of copper and rose-water, or permanganate of potash, answer admirably, especially the latter, in the proportion of two grains to the ounce of water. Diluted tincture of myrrh may sometimes be advantageously employed, and when the membrane is ulcerated, a solution of nitrate of silver will be highly serviceable. The author has used a solution of iodid of potassium with advantage, also a weak alcoholic solution of tannic acid and diluted tincture of iodin. After the use of the permanganate of potash, a carbolic solution, ʒj to water, ℥viij, or the antiseptic preparation, listerine, may

be used as an injection with decided benefit. The injection of a warm solution of salt and water is highly recommended as a preparatory step before making use of the permanganate of potash and the carbolic solution. For correcting the fetor of the secretions, a weak solution of chlorinated soda or lime, or a solution of permanganate of potash may be occasionally injected into the antrum.

In cases of simple muco-purulent secretion, a weak decoction of galls may be injected into the sinus with advantage. Injections of a too stimulating nature are sometimes employed. This should be carefully guarded against by making them at first weak, and afterward increasing their strength as occasion may require; and if symptoms of a violent character are by this means produced, they should be combated by applying leeches to the gums and fomentations to the cheek.

Dependent as these affections in most instances are upon local irritants, greater reliance is to be placed upon their removal and giving vent to the acrid puriform fluids, than on any therapeutical effects exerted upon the cavity by injections. As adjuvants they are serviceable, but cure cannot be effected while the exciting cause remains unremoved.

Dr. Frank Abbott recommends a thorough washing out of the antrum, immediately after an opening is made into it, with a warm solution consisting of a teaspoonful of salt to half a pint of water, injected with slight force, and if there is still an offensive odor, to syringe with the permanganate of potash solution; then with the carbolic solution or with listerine; and as a dressing, to be renewed daily, carbolized oil (1 part of carbolic acid to 15 parts of oil of sweet almonds) on cotton, so applied that it may be retained in the antrum, and secured by attaching it to a tooth or to a plate worn in the mouth. If no improvement is apparent after two or three days, the antrum is to be syringed with a solution consisting of one dram of carbolic acid, 1 ounce of tincture of iodin, and 8 ounces of water; and in some cases with a more powerful stimulant, such as 10 grains of chlorid of zinc to 1 ounce of water. For systemic treatment he recommends sulphid of calcium, one-tenth of a grain pill three times a day after meals, doubling the dose if necessary.

Epithelioma of the antrum is a malignant form of tumor which fills this cavity, destroying the walls and also the hard palate. A cancerous, mushroom-like formation sometimes attaches itself to the roof of the mouth. It may involve much surface before its true character is discovered, and it is very difficult to remove. In some cases the jaw must be removed, while in others, especially if the character of the disease is easily determined, a free opening must be made and the can-

cerous tissue scraped away, followed by repeated applications of chlorid of zinc or other strong escharotics.

For other tumors, etc., of the antrum, the reader is referred to "Tumors of the Mouth."

CHAPTER X.

CARIES OF THE MAXILLARY BONES.

Caries of the maxillæ, like necrosis, is not a very common disease, and differs from the latter in being analogous to ulceration in the soft parts, and in being free from the odor, when cleanliness is observed, which characterizes necrosis.

The symptoms of caries of bone resemble those of alveolar abscess, and when the acute form of the disease is present it is associated with inflammation of the gums and peridental membrane; periodontitis being early manifested when the carious condition of the bone results from diseased teeth. When caries of the maxillæ is well established, one or more fistulous openings exist in the gum or in some adjacent part; these openings being surrounded, in the majority of cases, by fungous granulations. The bone beneath is full of minute cells, and is of a soft consistence—a condition readily detected by the probe or an excavator, and differing very materially from the solid, resisting structure presented by bone when in a normal condition. Commencing like ordinary periostitis, there is present, in the early stage, increased vascularity and congestion, which terminates in ulceration; the bone cells becoming enlarged by the breaking down of their walls, and filled with semi-organized lymph, the accumulation of which is attended with a rapid advance of the destructive process. The numerous irregular cavities existing in the bone are lined by a glazed secreting surface. According to Virchow, "the bone breaks up in its territories, the individual corpuscles undergo new developmental changes (granulation and suppuration), and remnants composed of the oldest basis substance remain in the form of small, thin shreds in the midst of the soft substance. In ossification (in cartilage) there is a portion of the original intercellular substance of the cartilage cells (secondary cells), which, though it belongs to the group as a whole, yet, when these, in the course of ossification, are transformed into a number of isolated bone cells, becomes, comparatively speaking, almost entirely independent of those cells individually, and therefore escapes the changes which befall them."

It is this portion which remains behind the caries, while the secondary intercellular substance perishes. "At the moment a periosteal tissue quits the surface of a bone, and the vessels are drawn out from the cortex in inflammatory condition, we see, not as in normal bone, mere threads, but little plugs, thicker masses of substance; and if they have been entirely drawn out, there remains a disproportionately large hole, much more extensive than it would be under normal circumstances. On examining one of these plugs you will find that around the vessel a certain quantity of soft tissue lies—the cellular elements of which are in a state of fatty degeneration. At the spot where the vessel has been drawn out the surface does not appear even, as in normal bone, but rough and porous; and when placed under the microscope you remark those excavations, those peculiar holes, which correspond to the liquefying bone territories. If it be asked, therefore, in what way bone becomes porous in the early stage of caries, it may be said that the porosity is certainly not due to the formation of exudations, seeing that for these there is no room, inasmuch as the vessels within the medullary canals are in immediate contact with the osseous tissue. On the contrary, the substance of the bone in the cellular territories liquefies; vacuities form, which are first filled with a soft substance composed of a slightly streaky connective tissue, with fatty degenerated cells. The whole process is a degenerative ostitis, in which the osseous tissue changes its structure, loses its chemical and morphological character, and so becomes a soft tissue, which no longer contains lime."

Causes.—In the early stages of caries of the maxillæ, there is nothing to distinguish it from periodontitis; and although the causes of this disease are various, yet one of the most common is the presence of dead teeth and roots of teeth, and the superior maxilla is much more prone to its attacks than the inferior, and especially where the bone is of a loose, spongy character, as in the strumous and mercurial diathesis. In cases of ulceration and extensive destruction of the tissues of the face, resulting from syphilis or lupus, the maxillary bones may become carious, and terrible deformity follow, as in cases where it commences in the palate, and, destroying it, makes a common cavity of the mouth and nose and involves the face.

Treatment.—In the early stage of the acute form of caries of the bones of the jaws, such antiphlogistic remedies as cathartics, diaphoretics, hot foot baths, leeches, and counter-irritants may be resorted to. If a diseased tooth or teeth give rise to the inflammation, such should be removed if they cannot be successfully treated. Blood taken from the arm, and also dry cups, are often serviceable. If a depraved condition of the system is present, as is frequently the case, the disease

being of an asthenic type, such constitutional remedies as iron, quinin, cod-liver oil, and like tonics are indicated; and when the caries is established, injections of aromatic sulphuric acid in full strength, or the official sulphuric acid, one part to six or eight parts of water, or, when required, in equal parts, will dissolve the carious bone, relieve the irritation caused by its presence, and hasten the cure, having a stimulant effect upon diseased tissues, and exerting an antiseptic influence. Listerine may also be employed for its antiseptic properties in conjunction with the aromatic sulphuric acid, no other remedy proving so satisfactory in the treatment of this disease as the latter agent. Other agents in the form of injections have also been recommended, such as carbolic acid solution, tincture of iodin, compound tincture of capsicum, and chlorid of zinc.

The removal of the carious bone is often necessary by such appliances as rose-head drills, made for the purpose and operated by the dental engine, chisels, etc.

An incision is first made to expose the bone, and the carious portion is then cut away with the rose-head drill or chisel, causing but little pain, until normal structure is reached, which is easily distinguished by the difference in touch of the instrument. Comparatively slight hemorrhage occurs, as a general rule, and it is readily controlled by such styptics as a saturated solution of chlorid of zinc, Monsel's powder, or compression by means of hot sponges. In employing injections in the treatment of well-established caries of bone, great benefit results from the preparatory cleansing of the parts with warm water, and its use should never be omitted.

PART FOURTH.

MECHANICS.—DENTAL PROSTHESIS.

MECHANICS.

THIS branch of dental science teaches the art of replacing lost organs of the Mouth, or any lost parts thereof. It is now generally called Dental Prosthesis (replacement). Mechanical detail is its prevailing feature; substitution or replacement is its distinctive peculiarity.

Mechanical detail also distinguishes the Surgery of dentistry as compared with general surgery; but as a branch of dentistry, therapeusis, or the arrest of disease, is its distinctive peculiarity.

The one treats disease or irregularity of the natural organs; the other substitutes their loss by artificial ones. Both demand a skillful training of the hands, and equally require, for their fullest development, all the knowledge comprehended under the term Dental Science.

Dental Prosthesis includes the laws and principles which determine and regulate the processes employed in the construction of all forms of dental mechanism; also the properties and relations of all materials used in these processes. It gives rules for the replacement of—

1. Lost teeth.
2. Lost alveoli, or parts thereof.
3. Lost palate, hard and soft, or parts thereof.

The first division is the most important, because the most universally demanded.

The following is the order of operations in the REPLACEMENT OF LOST TEETH and classification of the various styles of work:—

1. Preparation of the mouth; including
   (*a*) Treatment of the mucous membrane.
   (*b*) Extraction or treatment of teeth and roots.
2. Impression of the mouth; including
   (*a*) Form and material of impression cups.
   (*b*) Description of impression materials.
   (*c*) Selection and manipulation of the same.
   (*d*) Preparation for the model.
3. The plaster model; including
   (*a*) General directions for making model.
   (*b*) Special forms adapted to subsequent uses.
   (*c*) Removal from impression.
   (*d*) Preparation for the operation of making the plate.

4. The base-plate; which is either
   (*a*) Permanent, in swaged work, or
   (*b*) Temporary, in plastic work.

The subsequent operations differ in their order and character so widely as to require a separate classification in

(A) Swaged work:—
   (1) Metallic die and counter-die, made by
      (*a*) Sand molding;
      (*b*) Dipping, or pouring;
      (*c*) Fusible metal process, or by
      (*d*) Pouring directly into the impression.
   (2) Refining and rolling plate.
   (3) Swaging plate (gold, silver, platinum, or aluminum).
   (4) Articulating impressions.
   (5) Adjustment on articulator.
   (6) Selection and fitting of teeth, and
   (7) Attaching them to base-plate, by
      (*a*) Soldering;
      (*b*) Vulcanite; Celluloid;
      (*c*) Porcelain continuous gum.
   (8) Finishing process.

(B) Plastic work:—
   (1) Temporary plate of
      (*a*) Wax, or gutta-percha;
      (*b*) Thick tin, or lead, foil.
   (2) Articulating impressions.
   (3) Adjustment on articulator.
   (4) Selection and fitting of teeth.
   (5) Preparation of the matrix.
   (6) Molding and hardening of the base-plate, made of
      (*a*) Vulcanite compounds, which harden by heat;
      (*b*) Celluloid compounds, which harden by heat;
      (*c*) Molten tin and other alloys, which harden on cooling;
      (*d*) Molten and swaged aluminum;
   (7) Which process at the same time attaches the teeth.
   (8) Finishing process.

The details of Swaged work vary according to the mode of making dies, the metal chosen for the plate, and the manner of attaching the teeth; but the order of operations is the same. The details of Plastic work vary also, according to the material composing the plate; but the order of operations is the same—differing from the former mainly because articulation follows the formation of the base-plate in one case, while in the other it precedes it.

These differences in the material of the base-plate give rise to a classification of Swaged work into

1. Gold plate ;
2. Aluminum plate ;
3. Platinum plate.

The first (and third) allows attachment of the teeth by soldering ; the second demands a vulcanite attachment ; the third alone permits, by virtue of its resistance to furnace heat, the addition of a continuous porcelain gum.

Plastic work is divided into

1. Vulcano-plastic ;
2. Cellulo-plastic ;
3. Metallo-plastic ;
4. Ceramo-plastic ;

The first is known as rubber work ; the second is known as celluloid work ; the third includes cheoplastic work, the old-fashioned block-tin base, all tin alloys and cast aluminum, etc. ; the fourth is known as the porcelain base.

In Prosthetic dentistry, swaged work is the patrician element ; plastic work the plebeian. When the latter runs riot, without the conservative influence of the former, the power of the people becomes a power for evil. This is precisely the danger which now threatens dentistry, in the abuse of certain most valuable processes and materials.

Facility of construction and cheapness of material have encouraged a style of practice in the highest degree detrimental to the profession. If such practice is inseparable from plastic work, it should be unhesitatingly abandoned by every one who holds the honor of dentistry dear to him. It becomes, also, a grave question how far the present mania for patents (another abuse of a valuable privilege) is beneficial to the reputation of a liberal profession.

CHAPTER I.

DENTAL PROSTHESIS.

Contributing, as the teeth do, to the beauty and expression of the countenance, to correct enunciation, and, through improved facility of mastication, to the health of the whole organism, it is not surprising that their loss should be considered a serious affliction, and that art should be called upon to replace such loss with artificial substitutes.

So great, indeed, is the liability of the human teeth to decay, and so much neglected are the means of their preservation, that few persons at the present day reach even adult age without losing one or more of these invaluable organs. Happily for suffering humanity, they can now be replaced with artificial substitutes so closely resembling the natural organs as to be readily mistaken for them, even by critical and practiced observers. Although there is a perfection in the work of nature that can never be equaled by art, artificial teeth are now so constructed as to subserve, at least to a great extent, the purposes of the natural organs. When properly adjusted, they are worn without the slightest discomfort; so much so, in many cases, that the patient, after they have been in the mouth a few weeks, is scarcely conscious of their presence.

The construction of artificial teeth is an operation which, though acknowledged to be of great importance, and performed by every one having any pretension to a knowledge of dentistry, is, unfortunately, but little understood by the majority of practitioners. The mouth is often irreparably injured by their improper application. A single artificial tooth, badly inserted, may cause the destruction of the two adjacent natural teeth or those to which the artificial appliance is secured; and if the deficiency thus occasioned be unskillfully supplied it may cause the loss of others; in this way all the teeth of the upper jaw are sometimes destroyed.

The utility of artificial teeth depends upon their proper construction and correct application. There is no branch of dental practice that requires more skill and judgment or more extensive and varied scientific information. A knowledge of the anatomy and physiology of the mouth, of its various pathological conditions and their therapeutical indications, is as essential to the mechanical as to the surgical dentist. To correct information upon these subjects must be added the ability to execute, with the nicest skill and most perfect accuracy, all the mechanism required in dental prosthesis.

There are difficulties connected with the insertion of artificial teeth of which none but an experienced dentist has any idea. They must be constructed and applied in such a manner that they may be easily removed and replaced by the patient, if upon a base; at the same time they must be securely fixed in the mouth and be productive of no injury to the parts with which they are in relation.

But perfect mechanism is not the sole element of success; often it is not the most essential one. To know when to extract and when to retain a root or a tooth; when to secure a piece by clasps and when by simple adaptation; when to use gold and when some other material; to determine the best form of a plate and the proper time for its

insertion ; finally, to determine when and what prosthetic skill can do, when and why it will fail—are a few of the problems in dental mechanics which demand for their correct solution a fullness and extent of information which are not always brought to bear, perhaps because, unfortunately, the necessity is not recognized as it should be.

Notwithstanding the triumphs of prosthetic dentistry and the high state of excellence to which it has arrived, at no previous time was there ever so much injury inflicted and suffering occasioned by artificial teeth as at present, resulting solely from their bad construction and incorrect application. That such should be the case when there are so many scientific and skillful dentists in every city and in many of the villages of the country may seem strange, but the fact is nevertheless undeniable. We may explain it in part by the very rapidly increasing demand for dental services, which has not allowed time for the development of intelligent and skilled labor, either of head or hand ; in part, also, by the universal experience that all new professions are full of immature and crude material. But these explanations cannot long be received in excuse for a state of things which ought to be rapidly disappearing—which is, in fact, giving way under the combined influence of our colleges, our periodicals, and text-books, the teachings and example of our eminent practitioners, and the more appreciative judgment of the public.

These remarks apply alike to the surgery and mechanism of dentistry. The latter has an additional barrier to progress in the common practice of delegating the greater part of its details to inexperienced, uninformed, and irresponsible assistants. Perfect dentistry demands equal skill and education in both departments. Each requires that its complete series of operations shall be the work of one person. If, therefore, the work of the two are so far incompatible that they cannot be combined, the separation should be complete. The semi-mechanism of the surgeon is like the semi-surgery of the mechanism. Each injures an otherwise perfect reputation ; both do harm to the profession they seek to honor.

In an excellent article on "Temperament in Relation to the Teeth," in the *Dental Cosmos*, Dr. James W. White writes as follows:—

"The value of a practical application of the study of temperament in the practice of dentistry is apparent. That the relation of the teeth to temperament is, as a rule, ignored by those engaged in prosthetic dentistry is evident in the mouths of a majority of those who are so unfortunate as to be under the necessity of wearing substitutes for lost natural dentures.

"A certain law of harmony in nature between the teeth and other physical characteristics necessitates respect to size, shape, color, and other qualities in an artificial denture, in order that it shall correspond

with other indications of temperament; and if teeth correlated in their characteristics to those which nature assigns to one temperament be inserted in the mouth of one whose physical organization demands a different type, the effect is abhorrent. The artificiality of artificial teeth is the subject of remark by those who have little or no conception of the reason therefor—simply an instinctive appreciation of the incongruity and unreality. It is, indeed, rare to see a case in which there is occasion for a moment's hesitation as to the fact of replacement. There is no dental service that, from the esthetic standpoint, is, as a rule, so ill performed as the prosthetic. Thousands of dentures are constructed which serve the needs of the wearer for speech and mastication, but which are nevertheless deserving of utter condemnation as art productions. More attention has been paid to the best methods of restoring impaired function—securing comfort and usefulness in artificial dentures—than to a correlation of the substitutes to the physical characteristics of the patient.

"What is needed is such an appreciation of the law of correspondence that the dentist can cipher out, as by the rule of three, the character of teeth required in the case of an edentulous mouth, with the same precision as the comparative anatomist can from a single bone indicate the anatomical structure of the animal to which it belonged."

The following illustrations and descriptions of the teeth as indicated by temperament are interesting and instructive:—

General Divisions.	Bilious.	General Divisions.	Sanguineous.
General color and quality of color.	Bronze-yellow, with strength or power of coloring.	General color and quality of color.	Cream-yellow, and inclined to translucency.
General form.	Large and inclined to angular; rather long in proportion to breadth.	General form.	Well proportioned; abounding in curved or rounded outlines; cusps rounding.
Surfaces of the teeth.	Inclined to transverse ridges and abounding in strong lines; neither brilliancy nor transparency of surface, but slight translucency.	Surfaces of the teeth.	Smooth, or nearly so; elevations and depressions rounded; cutting-edges and cusps translucent. Fair degree of brilliancy.
Articulation.	Firm and close; well locked.	Articulation.	Moderately firm; jaw inclined to rotate in mastication.
Gum margin or festoon.	Heavy and firm, but inclined to angularity.	Gum margin or festoon.	Round and full, as regards both breadth and depth.
Rugæ.	Heavy and rugged in shape; squarely set.	Rugæ.	Numerous and graceful in outline; not heavy, but well rounded.

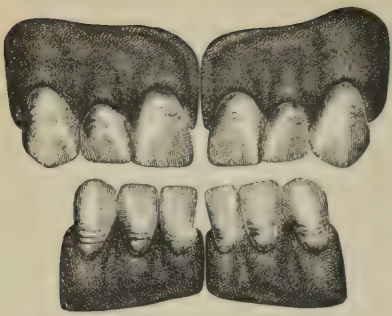


FIG. 609.—BILIOUS.

FIG. 610.—SANGUINEOUS.

FIG. 611.—NERVOUS.

FIG. 612.—LYMPHATIC.

GENERAL DIVISIONS.	NERVOUS.	GENERAL DIVISIONS.	LYMPHATIC.
General color and quality of color.	Pearl-blue or gray; inclined to transparency.	General color and quality of color.	Pallid and opaque, or muddy in coloring.
General form.	Length predominating over breadth; fine, long cutting-edges and cusps.	General form.	Large, but not shapely; breadth predominating over length; cusps poorly defined.
Surfaces of the teeth.	Brilliant and transparent depressions and elevations; abounding in long curves.	Surfaces of the teeth.	Surfaces of incisors devoid of depressions or elevations; opaque and dead in finish, even to cutting-edges.
Articulation.	Very long and penetrating.	Articulation.	Loose and flat.
Gum margin or festoon.	Delicate, shapely, and fine; oval in curve.	Gum margin or festoon.	Thick and undefined in shape.
Rugæ.	Close, not numerous; small and long.	Rugæ.	Sparse and flat.

We shall enumerate some of the different kinds of dental substitutes that have been employed since the commencement of the present century. We shall also notice briefly the principal methods that have been adopted in their application, before entering upon a minute description of those practiced at the present time. Great improvements have been made in dental prosthesis since the publication of the former editions of this work. In fact, no science or art, except chemistry, has been so eminently progressive during the last thirty years as mechanical dentistry.

CHAPTER II.

SUBSTANCES EMPLOYED AS DENTAL SUBSTITUTES

There are two qualities which it is highly important that dental substitutes should possess. They should be durable in their nature, and in their appearance should resemble the natural organs which they replace or with which they are associated.

The kinds of teeth that have been employed since 1820 are—

1. Human teeth.
2. Teeth of neat cattle, sheep, etc.
3. Teeth carved from the ivory of the elephant's tusk and from the tooth of the hippopotamus.
4. Porcelain teeth.

HUMAN TEETH.

As regards appearance only, which in a dental substitute is an important consideration, human teeth are preferable to any other, except, perhaps, the almost perfect recent productions of the dento-ceramic art. When formerly used for this purpose they were of the same class as those the loss of which they were to replace. The crowns only were employed, and if well selected and skillfully adjusted the artificial connection with the alveolar ridge could not easily be detected.

The durability of these teeth when thus employed depends upon the density of their texture, the soundness of their enamel, and the condition of the mouth in which they are placed. If they are of a dense texture, with sound and perfect enamel, and are placed in a healthy mouth, they may last from eight to twelve years, or even longer. The difficulty, however, of procuring these teeth was generally so great that it was seldom that such as we have described could be obtained; and even when it was possible the mouth, in half the cases in which such teeth were placed, was not in a healthy condition; its secretions often

so vitiated and of so corrosive a nature as to destroy them in less than four years. We have even known them to be destroyed in two, and in one case in fifteen months.

A human tooth artificially applied is more liable to decay than one of equal density having a vital connection with the general system, for the reason that its dentinal structure is more exposed to the action of deleterious chemical agents. Yet of all the *animal substances* employed for this purpose human teeth are unquestionably the best. They are harder than bone, and being more perfectly protected by enamel, are consequently more capable of resisting the action of corrosive agents.

Many object to having human teeth placed in the mouth, under the belief that infectious diseases may be communicated by them. But the purifying process to which they are previously submitted greatly diminishes this danger. When the practice of transplanting teeth was in vogue occurrences of this sort were not unfrequent, but since that has been discontinued these have seldom, if ever, happened. Still, the prejudice against human teeth is so strong that it is impossible, in most cases, to overcome it. This feeling, the difficulty of procuring them, the high price they command, and their want of durability, have gradually led to their entire disuse, which is scarcely to be regretted, now that art can produce in porcelain such accurate imitations of nature. The only case in which we might feel called upon to insert natural teeth is where any of the twelve front teeth become loosened by periosteal disease and drop from their sockets while yet perfectly free from caries. These teeth may often be adjusted to a plate so as to present an exceedingly natural appearance.

TEETH OF CATTLE.

Of the various kinds of natural teeth employed for dental substitutes, those of neat cattle are, perhaps, after human teeth, the best. By slightly altering their shape they may be made to resemble the incisors of some persons; but a configuration similar to the cuspids cannot be given to them, and in most cases they are too white and glossy. The contrast, therefore, which they form with the natural organs should constitute, were they in all other respects suitable, a very serious objection to their use. Imitation of nature has been too much disregarded, both by dentists and patients. Indeed, many of those who need artificial teeth wish to have them as white and brilliant as possible, and some practitioners lack either the decision or the judgment to refuse compliance with a practice which destroys all that beauty and fitness which it is the aim of dental esthetics to cultivate.

There are other objections to the use of these teeth. In the first

place, they are only covered anteriorly with enamel; in the second, their dentinal structure is less dense than that of human teeth, and, consequently, they are more easily acted on by chemical agents. They are, therefore, less durable, seldom lasting more than from two to four years. Another objection to their use is, they can be employed in only the very few cases where short teeth are required, owing to the large size of their nerve cavities. It is seldom, therefore, that they can be advantageously used as substitutes for human teeth.

IVORY OF THE ELEPHANT AND HIPPOPOTAMUS.

Artificial teeth made from the ivory of the tusk, both of the elephant and the hippopotamus, have been sanctioned by usage from the earliest periods of the existence of this branch of the art. We must not hence conclude that it has been approved by experience; on the contrary, of all the substances that have been used for this purpose this is certainly the most objectionable.

The ivory of the elephant's tusk is decidedly more permeable than that obtained from the hippopotamus. So readily does it absorb the buccal fluids that, in three or four hours after being placed in the mouth, it becomes completely saturated with them. Consequently, it is not only liable to chemical changes, but the absorbed secretions undergo decomposition; and when several such teeth are worn, they affect the breath to such a degree as to render it exceedingly offensive. Again, on account of its softness, teeth are easily shaped from it; but, not being covered with enamel, they soon become dark, and give to the mouth a repulsive appearance. Fortunately, however, in the United States elephant's ivory is rarely used, either as a base-plate or for the teeth themselves.

The ivory of the tusk of the hippopotamus is much firmer in its texture than that obtained from the elephant; being covered with a hard, thick enamel, teeth may be cut from it which, at first, very closely resemble the natural organs. There is, however, a peculiar *animation* about human teeth, which those made from this substance do not possess; moreover, they soon change their color, assuming first a yellow, and then a dingy bluish hue. They are, also, like elephant ivory, very liable to decay. We have in our possession a number of blocks of this sort, some of which are nearly half destroyed. The same objection lies against teeth made from the hippopotamus ivory, sufficient to condemn its use. Like those formed from elephant ivory, they give to the breath an offensive odor, which no amount of care or cleanliness can wholly correct or prevent.

PORCELAIN OR INCORRUPTIBLE TEETH.

The manufacture of porcelain teeth did not for a long time promise to be of much advantage to dentistry. But through the ingenuity and indefatigable exertions of a few, they have, within the last thirty years, been brought to such perfection as to supersede all other kinds of artificial teeth.

The French, with whom the invention of these teeth originated, encouraged their manufacture by favorable notices ; and the rewards offered by some of the learned and scientific societies of Paris contributed much to bring it to perfection. They were still, however, deficient in so many particulars that they received the approbation of very few of the profession, and then only in some special cases. It is principally to American dentists that we are indebted for that which the French so long labored in vain to accomplish.

A want of resemblance to the natural organs in color, translucency, and animation was the great objection urged against porcelain teeth ; and, had not this been obviated, it would have constituted an insuperable objection to their use. Until 1833 all that were manufactured had a dead, opaque appearance, which rendered them easy of detection when placed beside the natural teeth, and gave to the mouth an unnatural aspect. But so great have been the improvements in their manufacture that few can now distinguish betwen the natural teeth and their artificial companions, if well selected and skillfully applied.

The advantages which mineral teeth possess over every sort of animal substance are numerous. They can be more readily secured to the plate and are worn with greater convenience. They do not absorb the secretion, and, consequently, when proper attention is paid to their cleanliness they do not contaminate the breath or become in any way offensive. Their color never changes. They are not acted on by the chemical agents found in the mouth, and hence the name *incorruptible*, which has been given them.

Porcelain teeth are divided into single, sectional, carved-block, continuous gum, pivot-crown teeth, and porcelain facings, all of which consist of a body and enamel.

The body or base is composed of silex, feldspar, and kaolin, while the enamel is principally composed of feldspar, and is colored by means of metals in a state of minute division, or in the form of oxids. The principal metals employed for this purpose, and which give the positive tints, are gold, platinum, and titanium. Gold, in a state of fine division, imparts a rose-red tint ; the same metal, in the form of an oxid, gives a bright rose-red tint. Platinum, in the form of sponge and filings, imparts a grayish-blue tint. Titanium, in the form of an

oxid, imparts a bright yellow tint. Other metals, in the form of oxids, are also employed to color porcelain teeth, such as uranium, which gives a greenish-yellow tint; manganese, a purple tint; cobalt, a bright blue tint; silver, a lemon-yellow tint; zinc, also a lemon-yellow tint; and purple of Cassius, a rose-purplish tint. By combining the tints, using some to soften others, the different shades of color required to impart character and a life-like appearance to artificial teeth are obtained.

The vast extension of mechanical practice is due, more than to any other one cause, to these improvements in the manufacture of porcelain teeth—improvements essentially American, and so important as fairly to justify a little of that boasting spirit which, transplanted from the mother country, has attained such luxuriant growth on American soil.

The beautiful exact imitation of the varying shades of the natural gum, which as yet has been found possible only in porcelain, would of itself give to this material a claim over every other. All attempts to color ivory have failed to produce any permanent results. More recent experiments in the several vulcanizable materials have thus far given opaque and lifeless colors, which no stretch of imagination can compare with the natural gum, the nearest approach to a proper color being the celluloid base. When a material shall have been discovered possessing the valuable properties of the vulcanite combined with the beauty of a porcelain artificial gum, dental prosthesis will have nearly reached perfection.

The late Dr. James W. White, in a popular treatise on "The Teeth," remarked: "The observant dentist will take into account complexion, age, sex, height, the color of hair and eyes, and other characteristics of the individual, when selecting teeth to replace lost ones; and the manufacturer should be skilled in the observance of the varied classes of denture required. To inattention in this direction on the part of the dentist, or to dictation on the part of the patient, is to be charged the unseemly incongruities constantly staring the observer in the face from mouths whose lost organs have been replaced in disregard of this universal law. No matter how anatomically correct or how skillfully adapted for speech and mastication an artificial denture may be, yet if it bear not the relation demanded by age, temperament, facial contour, etc., it cannot be otherwise than that its artificiality will be apparent to every beholder. Artificial teeth should be natural as to shape, color, and vital appearance; there should be a nice blending of the colors of the body and enamel, not an abrupt union of the two; there should be the precise amount of translucency and the peculiar texture of the surface; and these characteristics should be maintained by artificial light as well as by daylight; for many teeth

which in daylight look reasonably well have an artificial appearance when exposed in the mouth to an artificial light. They should also possess strength sufficient for the uses for which they are designed. Besides all this there must be taken into account the varying forms of the jaws or maxillary ridge, so that the dentist may be enabled to select teeth which are adapted to each particular case, and which can be made to articulate nicely with other or with the natural teeth, if there are any remaining in the mouth; otherwise his best efforts will not secure a good appearance, comfort to the wearer, or usefulness in mastication."

CHAPTER III.

RETENTION OF ARTIFICIAL TEETH.

THE methods of retaining artificial teeth in place are—first, by pivoting to the natural roots; second, by attaching to metallic or other kind of base-plate, secured either by, 1, clasps or caps; 2, spiral springs; or, 3, atmospheric pressure. The peculiar advantages of each of these methods we shall now proceed to point out, and the cases to which they are particularly applicable.

ARTIFICIAL TEETH PLACED ON NATURAL ROOTS.

This method of securing artificial teeth was formerly, on account of its simplicity, more extensively practiced than any other; and, under favorable circumstances, it answers as well as any that can be adopted. If the roots on which they are placed be sound and healthy, and the back part of the jaws supplied with natural teeth, so as to prevent those with which the artificial antagonize from striking them too directly, they will subserve the purposes of the natural organs as perfectly as any other description of dental substitute, and can be made to present an appearance so natural as to escape detection upon the closest scrutiny. If properly fitted and secured, not only is their connection with the natural roots not easily detected, but they may render valuable service for many years.

The pivoting of the lower incisors, from their small size and the dangerous sequelæ of abscess, is frequently an unsatisfactory operation. Many upper laterals are also too small to admit a pivot. In practice the pivoting of cuspids is seldom called for. These teeth being very persistent, their loss usually implies that of many, perhaps all others, and the entire deficiency is replaced by teeth attached to a base-plate.

The insertion of an artificial tooth on a diseased root, or on a root having a diseased socket, is almost always followed by injurious consequences. Filling the root, together with proper accompanying treatment, will sometimes so completely arrest disease as to make pivoting safe; but there is always risk in these cases. The morbid action already existing in the root or its socket is aggravated by the operation, and often caused to extend to the contiguous parts, and occasionally even to the whole mouth. Even in a healthy root it is not always proper to apply a tooth immediately after having prepared the root. If any irritation is produced by this preparatory process, the tooth should not be inserted until it has wholly subsided. The neglect of this precaution not unfrequently gives rise to inflammation of the peridental membrane and to alveolar abscess.

Apart from the condition of the root, the question of pivoting—or of a plate tooth without gum resembling a pivot tooth—may depend upon the adjoining tooth or roots. If in any space to be supplied one root is absent all should be extracted, for the peculiar beauty of a pivot tooth is lost if its neighbor has an artificial gum.

Although this method of securing artificial teeth has received the sanction of the most eminent dental practitioners, and is one of the best that can be adopted for replacing loss in the six upper front teeth, yet, on account of the facility with which the operation is performed, it is often resorted to under most unfavorable circumstances, in consequence of which the method has been undeservedly brought into discredit. Apart from the proneness of operators to resort to this method when its adoption is unjustifiable, we may name two objections to the use of pivot teeth as formerly prepared and inserted. First, the difficulty of preventing the presence of secretions between the crown and root, which make the breath offensive and cause the root gradually to decay. Secondly, the more or less rapid enlargement of the canal, requiring frequent replacement and the ultimate loss of the root. The more recent methods, however, many of which consist in improvements upon the older methods, have obviated these objections in a great measure.

The efforts of the economy for the expulsion of the roots of the bicuspid and molar teeth after the destruction of their lining membrane, are rarely exhibited in the case of roots of teeth occupying the anterior part of the mouth. This circumstance has led us to believe that the roots of these teeth receive a greater amount of vitality from their investing membrane than do the roots of those situated further back in the mouth; and that the amount of living principle thus supplied is sufficient to prevent them from becoming manifestly obnoxious to their sockets.

Another explanation assumes the equal vitality of all the roots, and attributes the persistence of front roots, upon which a crown has been placed, to the continuance of that pressure to which it was subject so long as it had its natural crown. It is asserted in maintenance of this view, that front roots left to themselves will disappear in the same manner as bicuspid and molar roots, and that the latter may be retained if the artificial crown (attached to a plate) is set upon them; also, that the process of expulsion is analogous to that by which a tooth is elongated which has lost its antagonist.

It is well known that a dead root is always productive of injury to the surrounding parts, and that nature calls into action certain agencies for its expulsion. Therefore, attaching a tooth to a completely dead root is manifestly improper; but the roots of the front teeth are rarely entirely deprived of vitality, and hence, after the destruction of their pulps, they remain useful for many years without very obviously affecting the adjacent parts.

Teeth, attached to a plate, and resting upon natural roots which are in as healthy condition as it is possible for such roots to be, have all the beauty which so strongly recommends pivot teeth. They are not so securely held in position; but the ability to remove them is in itself an advantage. This method is applicable in many cases where the drilling for a pivot is impossible. The reader is referred to the chapter describing the different methods of pivoting teeth.

THE ARTIFICIAL TEETH SECURED BY CLASPS.

This method of securing artificial teeth, first introduced by the late Dr. James Gardette, of Philadelphia, is, perhaps, in particular and otherwise favorable cases, one of the firmest and most secure that can be adopted. By this means, the loss of a single tooth, or of several teeth, may be supplied. A plate may be so fitted to a space in the dental circle and secured with clasps to other teeth as to afford a firm support to six, eight, or ten artificial teeth.

Teeth applied in this way, when properly constructed, will last for several years, and sometimes during the life of the individual. But it is essential to their durability that they should be correctly arranged, accurately fitted, and firmly secured to the plate; that the plate itself be properly adapted to the gums, and the clasps attached with the utmost accuracy to teeth firmly fixed in their sockets.

Gold is perhaps the best material that can be employed for both plate and clasps. Since the application of vulcanized rubber to dental purposes, plates of this latter material with gold clasps attached have been much used. When gold is employed for the plate it should be from 20 to 21 carats fine, and from 18 to 19 for the clasps.

If gold of an inferior quality is used, it will be liable to be acted on by the secretions of the mouth. Platina perfectly resists the action of these secretions, and would, perhaps, answer the purpose as well as gold were it not for its softness and pliancy ; in full cases, and in some partial cases, the shape of the plate may more or less overcome this difficulty, especially when, as in the continuous gum work, stiffened by other materials.

The plate should be thick enough to afford the necessary support to the teeth ; but not so thick as to be clumsy or inconvenient from its weight. The clasps generally require to be about one-third or one-half thicker than the plate, and sometimes double the thickness. The gold used for this purpose is sometimes prepared in the form of half-round wire ; but in the majority of cases it is preferable to have it flat, as such clasps afford a firmer and more secure support to artificial teeth than those that are half round ; they also occasion less inconvenience to the patient, and are productive of less injury to the teeth to which they are attached.

Artificial teeth, applied in this way, may be worn with great comfort and can be taken out and replaced at the pleasure of the person wearing them. It is important that they should be very frequently cleansed to remove the secretions of the mouth that get between the plate and gums and between the clasps and teeth, which, becoming vitiated, may irritate the soft parts and corrode the teeth and taint the breath. This precaution should on no account be neglected. Great care, therefore, should be taken to fit the clasps in such a manner as will admit of the easy removal and replacement of the piece, and also that they may not exert any undue pressure upon the teeth to which they are applied.

If the clasp, in consequence of inaccurate adjustment, strains the position of the tooth in its socket, it may excite inflammation in the peridental membrane, and the gradual destruction of the socket will follow as a natural consequence. Also, if the clasp press too closely upon the neck of the tooth it may develop a morbid sensibility in the cementum, causing great annoyance and possibly exciting inflammation and alveolar absorption or loosening of the tooth.

Some years since Dr. Goodall obtained a patent for a method of retaining partial sets of artificial teeth by elastic or spring plates of vulcanized rubber, the utility of which, indiscriminately applied, as well as the validity of the patent, some were disposed to doubt, contending that these plates differ but little from metallic ones formerly in use, constructed in the same manner, and described as partial or stay-clasps.

This form of clasp, instead of embracing the natural tooth, simply presses against the inner surface of the contracted portion of the crown

near the gum, with a force which is sufficient to keep the substitute in place.

Professor Austen's method of taking plaster impressions in partial cases was designed by him in 1858, with special reference to obtaining an accurate copy of the inner surface of bicuspids and first molars. Accurate fitting of the vulcanite plate against one or two such teeth on each side prevents lateral motion and gives great stability to the piece. It takes the place of the vacuum cavity with much better results; in fact, he regarded this form of stay-plate essential to every partial piece not clasped, whilst he regarded the cavity worse than useless.

The reader is referred to the chapter describing the method of retention by clasps.

ARTIFICIAL TEETH WITH SPIRAL SPRINGS.

The difference between the method of applying artificial teeth last noticed and the one now to be considered consists in the manner of confining them in the mouth. The former is applicable in cases where there are other teeth in the mouth to which clasps may be applied; the latter is designed for confining a double set; more rarely a single set or part of a set. When plates with spiral springs are used, the teeth are attached to them in the same manner as when the clasps are employed, but instead of being fastened in the mouth to other teeth, they are kept in place by means of the spiral springs, lying one on each side of the artificial dentures between them and the cheeks, passing from the upper piece to the lower.

Spiral springs were formerly much used, and various other kinds of springs have since been suggested. When spiral springs are of the right size and attached in a proper manner they afford a very sure and convenient support. They exert a constant pressure upon the artificial pieces, whether the mouth is opened or closed. They do not interfere with the motions of the jaw, and, although they may at first seem awkward, a person will soon become so accustomed to them as to be almost unconscious of their presence. They are, however, liable to derangement from accident; they make the piece awkward to handle in the necessary daily cleansing; they retain the secretions offensively, and not unfrequently are a source of much irritation to the cheek.

It is, therefore, a subject of congratulation that successive improvements in the process of adapting the plate to the mouth have gradually lessened the number of cases in which spiral springs are thought necessary. It is now rare to meet with a case in which they are absolutely essential for the permanent retention of the piece. Occasional use is made of them for the temporary retention of a piece made soon after extraction, in which the plate is designedly made

more even than the irregular alveolar border, which plate cannot, of course, fit the mouth until the inequalities of the gum have yielded to the pressure of the plate.

TEETH RETAINED BY ATMOSPHERIC PRESSURE.

The method of confining artificial teeth in the mouth last described is often inapplicable, inefficient, and troublesome, especially for the upper jaw; in such cases the atmospheric pressure, or suction method, is very valuable. It was, for a long time, thought to be applicable only to an entire upper set, because it was supposed that a plate sufficiently large to afford the necessary amount of surface for the atmosphere to act upon could not be furnished by a piece containing a smaller number of teeth. Experience, however, has proved this opinion to be incorrect. A single tooth may be mounted upon a plate presenting a surface large enough for the atmosphere to act upon for its retention in the mouth; but when only a partial upper set is required it is often more advisable to secure the piece by means of cap-crowns to which a bridge is attached. For a like reason it was thought that the narrowness of the inferior alveolar ridge would preclude the application of a plate to it upon this principle, and in this opinion the author once coincided; but he has succeeded so perfectly in confining lower pieces by this means that he now never finds it necessary to employ spiral springs for their retention.

The principle upon which this plan is founded may be simply illustrated by taking two small blocks of marble or glass, the flat surfaces of which accurately fit each other. If, now, the air between them is replaced by water, the atmospheric pressure upon their external surfaces will enable a person to raise the under block by lifting the upper. Upon the same principle a gold plate, or any other substance impervious to the atmosphere and perfectly adapted to the gums, may be made to adhere to them.

The firmness of the adhesion of the plate or base to the gums depends on the accuracy of its adaptation. If this is perfect it will adhere with great tenacity, but if the plate is badly fitted or becomes warped in soldering on the teeth, its retention will often be attended with difficulty. It is also important that the teeth should be so arranged and antagonized that they shall strike those in the other jaw on both sides at the same instant. This is a matter that should never be overlooked, for if they meet on one side before they come together on the other, the part of the plate or base not pressed upon may be detached, and, by admitting the air between it and the gums, cause it to drop.

Since in the act of mastication pressure is made on one side with no

counter-pressure on the other, this inequality will not necessarily detach a well-made piece. But when the upper molars are set so far from the median line of the mouth that the line of pressure falls outside the alveolar ridge, it is difficult to retain the best-fitting piece in place during mastication.

It is also of the utmost importance that, by proper selection of the impression material and judicious management of subsequent processes, the plate should bear upon the ridge more than upon the palate. In doing this, however, no more space should be left than a few days' wear will obliterate, giving absolute contact over the entire surface. For there is no kind of space, cavity, or chamber which gives so complete a vacuum as contact, or which secures such permanently useful adhesion of the plate.

The application of artificial teeth on this principle has been practiced for a long time. Its practicability was first discovered by the late Mr. James Gardette, of Philadelphia. But the plates formerly used were ivory instead of gold, and could seldom be fitted with sufficient accuracy to the mouth to exclude the air; so that, in fact, it could hardly be said that they were retained by its pressure; except in that class of cases in which the mouth, by virtue of a soft membrane, has power to adapt itself to the plate. Unless fitted in the most perfect manner, the piece is constantly liable to drop; and the amount of substance necessary to leave in an ivory substitute renders it so awkward and clumsy that a set of teeth mounted upon a base of this material can seldom be worn with much comfort or satisfaction.

The firmness with which teeth applied upon this principle can be made to adhere to the gums and the facility with which they can be removed and replaced renders them, in many respects, more desirable than those fixed in the mouth with clasps. But unless judgment and proper skill are exercised in the construction of the work, a total failure may be expected, or, at least, the piece will never be worn with satisfaction and advantage.

There were few writers, at the time of the publication of the first edition of this work, who had even adverted to this mode of applying artificial teeth. Drs. L. S. Parmly and Koecker had each bestowed on it a passing notice. The former, in alluding to the subject, thus remarks: "Where the teeth are mostly gone in both or in either of the jaws, the method is to form an artificial set by first taking a mold of the risings and depressions of every point along the surface of the jaws, and then making a corresponding artificial socket for the whole. If this be accurately fitted it will, in most cases, retain itself sufficiently firm by its adhesion to the gums for every purpose of speech and mastication."

Modifications of the atmospheric pressure principle have been made since 1845, by constructing the plate with an air-chamber or cavity, so that when the air is exhausted from between it and the parts against which it is placed, a more or less complete vacuum is formed, causing it to adhere when first introduced with greater tenacity to the gums than a base fitted without such cavity. This modification might be termed an improvement were it not that its introduction has become so unnecessarily general, has so often induced a diseased condition of the mucous membrane, and has led to a slovenly, careless method of swaging and fitting plates. For these and some other reasons, Professor Austen regarded its introduction as a positive detriment, at the same time that he acknowledged its occasional utility. He argued that theory and practice alike condemn the use of a cavity for the permanent retention of any piece, and suggests for its temporary retention, whilst the work is going through its stage of adaptation, some other plan than this permanent disfigurement. The so-called vacuum cavity can, at best, be only partially a vacuum, hence cannot give the amount of atmospheric pressure that perfect contact will. So long as it acts in the retention of a piece it necessarily draws the yielding membrane into the space, and must ultimately fill it. When this is done, the piece is evidently retained by the "vacuum of contact." If, in any case, the mouth does not show the size and depth of the cavity imprinted on the palate, it proves that the vacuum force is not exerted, and that the piece is retained by contact of the parts around the cavity. In these cases, of constant occurrence, the cavity diminishes the adhesion of the plate, and can only be of service where it helps to remove pressure from a hard palate. But as this can be done in a better way, it is no argument in favor of the cavity.

The only cases in which this chamber is permanently useful are very flat mouths with scarcely any perceptible ridge. A sharply defined cavity, varying in depth from one-half to one line, according to the softness of the membrane, when filled by this membrane, tends to prevent any lateral motion of the piece, so troublesome in such cases.

Partial pieces not retained by clasps, or the lateral pressure of stays, or their closeness of adaptation, are never permanently improved by the cavity. Even in pieces made soon after extraction the temporary action of the cavity is of questionable utility (see Chapter XIII). Devices known as "surface-cohesion forms" have also been suggested, which consist of thin metallic plates, the surfaces of which are covered with minute papilliform prominences, which, by displacement of mucus at the points of gum contact, effect surface cohesion and cause no irritation. They can be adapted to both upper and lower dentures.

CHAPTER IV.

PREPARATORY TREATMENT OF THE MOUTH.

THE condition of the mouth is not sufficiently regarded in the application of artificial teeth, and to the neglect of this the evil effects that so often result from their use are frequently attributable. An artificial appliance, no matter how correct it may be in its construction and in the mode of its application, cannot be worn with impunity in a diseased mouth. Of this fact every day's experience furnishes the most abundant proof. Yet there are men in the profession so utterly regardless of their own reputation and of the consequences to their patients as wholly to disregard the condition of the mouth, and are in the constant habit of applying artificial teeth upon diseased roots and gums, or before the curative process after the extraction of the natural teeth is half completed.

The dentist, it is true, may not always be to blame for omitting to employ the means necessary for the restoration of the mouth to health. The fault is often with the patient. There are many who, after being fully informed of the evil effects which must of necessity result from such injudicious practice, still insist on its adoption. But the dentist, in such cases, does wrong to yield his better informed judgment to the caprice or timidity of his patient, knowing, as he should, the lasting pernicious consequences that must result from doing so. If he is not permitted to carry out such plan of treatment as may be necessary to put the mouth of his patient in a healthy condition previously to the application of artificial teeth, he should refuse to render his services. No professional man can be permitted to plead in excuse for any professional error that his patient over-persuaded him. No community will accept such excuse, or hold the patient in any degree responsible for the consequences.

Dr. Koecker, in treating upon this subject, says: "There is, perhaps, not one case in a hundred requiring artificial teeth in which the other teeth are not more or less diseased, and the gums and alveoli, also, either primarily or secondarily affected. The mechanical and chemical bearing of the artificial teeth, even if well contrived and inserted upon such diseased structures, naturally becomes an additional aggravating cause of disease in parts already in a sufficient state of excitement; if, however, they are not well constructed, and are inserted with undue means or force, or held by too great or undue pressure, or by ligatures or other pernicious means for their attachment, the morbid effects are still more aggravated, and a general state of

inflammation in the gums and sockets, and particularly in the periosteum, very rapidly follows. The patient, moreover, finds it impossible to preserve the cleanliness of his mouth; and his natural teeth, as well as the artificial apparatus, in combination with the diseases of the structures, become a source of pain and trouble; and the whole mouth is rendered highly offensive and disgusting to the patient himself as well as to others."*

The first thing, then, claiming the attention of the dentist, when applied to for artificial teeth, is to ascertain the condition of the gums and of such teeth as may be remaining in the mouth. If either or both are diseased, he should at once institute such treatment as the circumstances of the case may indicate; but as this has been described in a preceding chapter, the reader is referred for directions upon the subject to what is there said. Without, however, repeating previous medical and surgical directions, a few brief hints are necessary as to what teeth or roots should be extracted and what allowed to remain in preparation for a dental plate.

All incurably diseased roots or teeth should be removed, also all roots of molars in either jaw, and all roots, without exception, in the lower jaw. Firm and healthy roots of bicuspids may sometimes be retained, the plate coming to the inner edge of such root and the artificial crown resting upon it. It is desirable to retain upper incisors or canine roots, unless an adjacent tooth has lost its root or is incurably diseased. These cases of retention of roots presuppose the presence of other teeth; for when only roots remain in the jaw they must be extracted. Also, they must be removed, however sound, if they are sources of irritation in, or are partially covered with, mucous membrane.

Very loose teeth, although not carious, should be extracted; but teeth in which caries or abscess can be permanently cured rank as sound teeth. All sound teeth must be retained, if there are more than four in either jaw, unless some peculiar circumstances justify their removal. Cases of this kind are so varying that no fixed rule can be laid down; but a few cases may be given in illustration of the principles that should guide the practitioner.

Two, three, or four molars alone remaining should be retained, especially if they have antagonists. They do not complicate the construction of the piece or interfere with its utility; but they should not be clasped, since the whole weight being in front of the clasp brings too much strain on the teeth. Two, three, or four incisors alone remaining cannot be extracted except by request of the patient; for

* Koecker's "Essay on Artificial Teeth," pp. 27, 28.

although they complicate the construction, and may interfere somewhat with the strength and beauty of the work, they may be too valuable to justify their loss. The cuspids must be retained, if sound, not displaced, and free from alveolar absorption, although their retention may greatly complicate the work.

In cases of protrusion of the lower jaw, it may be advisable to extract the five front teeth in either jaw, where these are the sole remaining ones, with a view to correct, in part, the protrusion of the mouth. But this cannot be done without fullest consent of the patient; even then is scarcely advisable unless these teeth are frail in texture, or their position amounts to deformity.

In all cases it should be the rule never to sacrifice a sound tooth for the purpose of replacing an artificial one, unless the benefit of the exchange is so undoubted as to be recognized by both patient and operator.

When artificial teeth are to be secured in the mouth in any other way than by pivoting upon the roots, if the patient desires but one piece, sufficient time should elapse before its insertion for the completion of those changes in the alveolar ridge that follow extraction.

It is often necessary to wait from eight to fifteen months, after the removal of the natural teeth, for the completion of these changes. Comparatively few persons, however, are willing to remain for so long a time without teeth; nor, on many accounts, is it desirable that they should. In this long interval the lips lose somewhat their natural expression, and the under jaw forgets its natural motion and inclines to project. The artificial piece or pieces feel more awkward and unmanageable than if inserted at once; they also interfere more with the articulation and motions of the tongue, which have become accustomed to the absence of the teeth.

Hence the insertion of artificial pieces may become advisable very soon after extraction — the interval varying from hours or days to weeks or months. In some of these cases the piece will have to be remodeled at short intervals; in other cases the piece, as first made, continues to be worn for many years with much comfort. It is not easy to explain these differences. Much depends upon the nature of the mucous and submucous tissues, whether hard or soft; and much also upon the manner in which the alveolar ridge changes. It may take place rapidly, and with slight regard to the shape of the plate; in which case the patient has to use much tact in retaining the piece in place. Or it may take place slowly, following, as it is apt more or less to do, the shape of the plate; in which case it may be worn with some comfort, or even with great satisfaction, for a long time.

A plate made immediately after extraction should not fit the ridge exactly; but allowance should be made for the rapid absorption of the prominent edges of the alveoli. Some practitioners advise the anticipation of this process by "paring down" the alveolar ridge. This "bold surgery" has its advantages and its advocates. The operators say it does not hurt much; but the testimony of the patient on this point is more trustworthy.

The almost universal use of the term "temporary," applied to a piece made within six months after extraction of the teeth, is much to be regretted. It tempts the dentist to a slovenly style of half-made work, good enough, in his estimation, for what is so soon to be replaced. It also renders the patient reluctant to make proper compensation for the time and skill employed. Both feelings react, until it has become a notorious fact that much low-priced work passes from the hands of skillful mechanicians which they would indignantly disown as specimens of their workmanship.

Yet they are specimens which a community is right in judging by. It is unfortunate for dentistry that so many, using their best efforts, accomplish poor results. But it is infinitely more damaging to its character that a skilled operator should, under any pretext, permit himself to be false to the trust reposed in his professional capacity. A chain is judged by its weakest link, and a workman's reputation turns on his poorest work. This seemingly harsh verdict is a just one, because necessary to keep the majority of men to the full measure of their ability.

Let the work be done as if it never was to be done again. Many circumstances may prevent the return of the patient; it also frequently happens that no necessity is felt, especially if properly done, for the renewal of the piece. If the patient understands that the necessity of renewal is not in the work itself, but arises from unavoidable changes in the mouth, there will be no difficulty about proper compensation. But if the absurd practice of half-price at one time for what receives full price at another must be maintained, then by all means let the second piece be the half-paid one.

The point, however, involves far higher questions than the one of fees. No dentist who properly respects himself or his profession will, either on the score of insufficient pay or temporary use, permit himself to issue two grades of work. Like Pharaoh's lean kine, the low grade will, slowly, perhaps, but inevitably, destroy the high grade. The only safe rule is "excelsior" in every case.

CHAPTER V.

CROWN AND BRIDGE-WORK.

Previous to the preparation of a natural root for the reception of an artificial crown, the remaining teeth and gums, if diseased, should be restored to health. This done, such portion of the crown as may not have been previously destroyed by caries should be removed.

A simple method of performing this part of the operation, when much of the crown remains, consists in cutting the tooth about three-fourths off with a file, a very fine saw (Fig. 613), or corundum or

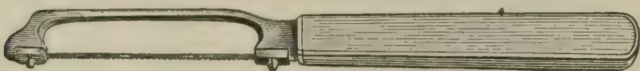


Fig. 613.

carborundum disc, and then removing it with a pair of excising forceps. But the forceps should not be applied until the tooth has been cut on every side, nearly to the pulp cavity, and even then great care is necessary to prevent jarring, or otherwise injuring the root. When too large a portion of the crown is clipped off suddenly with excising forceps, the concussion is often so great as to excite peridental inflammation and sometimes to fracture the root.

When excising forceps are used in this way, they should be strong, so as not to spring under the pressure of the hand, with cutting

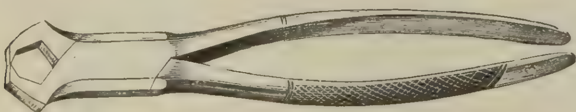


Fig. 614.

edges about an eighth of an inch wide (Fig. 614). But we should prefer, where a large part of the crown is left, to remove it entirely with the fine saw, or separating file, or corundum disc. Where there is only a jagged remnant of the crown left, it should be gradually cut away by a pair of cutting forceps made as light as possible, with a spring between the blades of the handles to keep them apart. The cutting edges may be shaped as in the ordinary excising forceps (Fig. 614), or somewhat like the beaks of Parmly's duck-bill root forceps, represented in Fig. 615.

After the removal of the remaining portion of the crown, the

pulp, if still alive, should be immediately destroyed by introducing a silver or untempered steel wire, or barbed broach, up to the extremity of the root by giving it at the same time a quick rotary motion. It is important that the instrument used for this purpose should be soft and yielding, otherwise any sudden motion of the patient might break it off in the tooth. Its extremity should also be

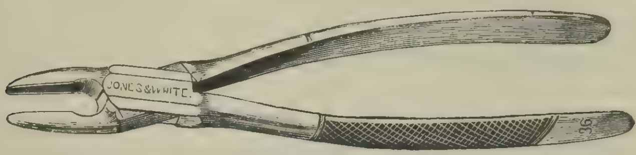


FIG. 615.

barbed or bent so as to entangle and drag out the pulp when withdrawn. (See Fig. 509, page 556.)

The pulp having been destroyed, the remainder of the operation will be painless. The root may now be filed or ground off a little above the free edge of the gum with an oval or half-round file, or a corundum wheel with a round edge. The file should be new and sharp, so as to cut rapidly, but not too coarse, lest it jar the root too much.

FIG. 616.

FIG. 617.

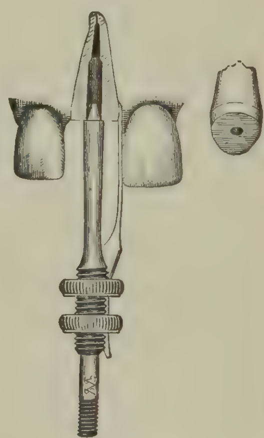


FIG. 618.

It must be kept cold and clean by frequently dipping in water; also the corundum wheel. Fig. 619 represents pivot files and wheels. The exposed extremity of the root after having been thus filed should present a slightly arched appearance, corresponding with the festooned shape of the anterior margin of the gum. Fig. 620 represents the Herbst rotary file for rapidly cutting natural roots to receive artificial

crowns. Fig. 621 represents safe-side corundum crown-wheels to grind off the root without injuring the adjacent tooth. Instruments called root-trimmers or reducers are then employed for trimming the edges,

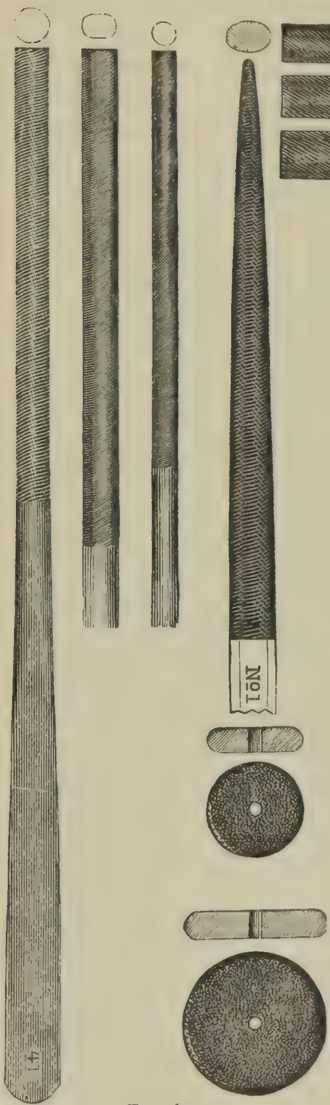


Fig. 619.

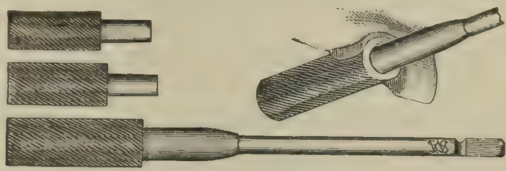


Fig. 620.

Fig. 621.

or in the case of collar-crowns, for reducing the diameters of roots over which collars are to be placed.

Figs. 616, 617, and 618 represent Evans', Starr's, and How's root-trimmers or reducers.

After having completed this part of the operation, the natural canal in the root should be slightly enlarged with a bur-drill, or a broach prepared for the purpose. A slightly projecting point on the end of the drill will serve, by entering the canal, to guide the instrument, which must be held steadily in one direction. The canal thus formed in the root for the pivot should never exceed the sixteenth part of an inch or a line in diameter, or a quarter or three-eighths of an inch in length.

If, from any peculiar constitutional susceptibility, there is reason to apprehend inflammation of the peridental membrane, the insertion of the tooth may be delayed a few days for the subsidence of any irritation which may have been

occasioned by the preparation of the root. It will be prudent to do this in all cases, although it rarely happens that the operation is followed by any unpleasant effects unless the pulp has previously lost its vitality by spontaneous disorganization or been destroyed by an arsenical application.

In such cases the contents of the canals must be removed, and the canals must be disinfected with peroxid of hydrogen, and a permanent aseptic condition, by mummification of the contents of the tubuli, be established, together with closure of the apical foramen, after the root-canal is prepared.

The root-canal is then opened by means of the drills and reamers represented by Figs. 515 and 516, page 559, and when this is accomplished it is syringed out with tepid water, and, after drying with cotton, is dehydrated with absolute alcohol, or by a current of hot air introduced by a hot-air syringe. The application of an antiseptic solution, such as bichlorid of mercury or peroxid of sodium, may follow the dehydrating process in all cases where such agents are deemed necessary for the purpose of establishing a purely aseptic condition.

After having prepared the root, an artificial crown of the right shape, color, and size is accurately fitted to it. It should touch every part of the filed extremity of the root, and be made to rest firmly upon it, to give security of support, and to exclude food and other substances which, by their decay, will give rise to unpleasant odors. Care must also be used to have the tooth placed in exact line with the other teeth, not inclining unnaturally to either side, and not so long as to touch the lower teeth when the mouth is closed. To fit the crown accurately is often a tedious process and wearies the patient. To avoid this an impression of the exposed end of the root and of the space between the adjoining teeth may be taken and the crown adapted to the model, which should be hardened by varnish or soluble glass; an antagonizing model is also useful.

The canal in the root and that in the artificial crown should be directly opposite to each other.

In selecting a suitable artificial crown, it is often difficult to find the several conditions of length, width, color, and position of pivot hole just as required. The last two cannot be changed, but the first two may often be modified by the corundum wheel. If the color cannot be exactly matched, it is perhaps better to select one a shade darker, rather than lighter.

For grinding the edges, sides, or base of the tooth, any of the hand or office foot-lathes in use will answer, or the corundum or carborundum points may be employed.

The artificial crown is secured to the root by means of a pivot or

post made of metal; gold, platinum, or platinum and iridium is to be preferred, inasmuch as silver or any baser metal is liable to be oxidized by the fluids of the mouth.

Wood, either seasoned hickory or locust, was formerly employed for the post, but metal is now generally employed, as it presents many advantages over the wood on account of strength, cleanliness, and durability.

It is important that the pivot should exactly equal the depth of the canal. If too long, the crown will not go up to its place; if too short, there will be either an unnecessary weakening of the root or the crown will be insecure. A small piece of smooth wire or knitting needle,


FIG. 622.

with a sliding collar of wood or gutta-percha, forms a simple instrument for measuring the depth of the canal in the root. Fig. 622 represents a convenient gauge for this purpose.

The end of the metallic post going into the artificial crown may be fastened in either of the following ways: First, by cutting a screw on it with a screw-plate, and then filling the post-hole with zinc cement and inserting the end of the post into it, which should be large enough to nearly fill the cavity. The projecting part of the pivot should be about half an inch in length. It is generally made square and pointed, as in the figure. The appearance of a porcelain tooth prepared with a metallic pivot for insertion in this manner is shown in Fig. 623.


FIG. 623.


FIG. 624.

In some cases a plate tooth may be considered preferable to one made expressly for pivoting. The manner of attaching a post to the former is as follows: The root is first prepared, after which an impression is taken; from this a plaster model is made, and from the latter metallic dies. This done, a piece of gold plate, large enough to cover the root, should be swaged up between the dies; a plate tooth of the proper size, shape, and color is then fitted to the root, backed with gold, and soldered to the plate. To the upper convex surface of this last, and immediately beneath the canal in the root, a metal pivot is attached. The position and direction of this pivot is thus secured. Press the plate, covered with a very thin film of wax, against the root; at the point opposite the canal, thus marked on the plate, drill a hole; through this pass a gold pivot into the canal; press softened sealing wax around the part of the pivot (made pur-

posely too long) below the plate, and remove the fixture from the mouth. Invest the upper part of the pin and plate in plaster (keeping it, by means of a minute collar of wax, out of the hole through which the pin passes), remove the sealing wax, cut off the pin even with the plate, and solder. A front and side view of a tooth thus prepared is shown in Fig. 624.

Porcelain crowns are now made with metallic posts baked in position. Fig. 625 represents such crowns with platino-iridium posts.

The double pin in the molar crowns prevents the loosening of these teeth by the rotary movements of mastication, which by means of the cusps exert such leverage as to turn and break down the ordinary crown where only one pin is used.

The roots are ground concave to fit the crowns with corundum or carborundum points or a countersink bur, and the close joints are made well under the gum, setting the pins with oxyphosphate cement.

It sometimes happens that the natural root, instead of occupying its proper position in the jaw, runs very obliquely; so that if the pivot connecting the artificial tooth to it be straight, the latter will

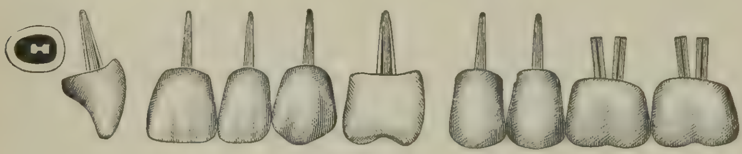


FIG. 625.

either overlap the adjoining teeth or else project outward or inward. To obviate this an angle should be given to the pivot immediately at the point of junction between the tooth and root. If this obliquity be slight, the pivot can easily be bent to suit; but in cases of greater obliquity a pivot or post made for the case will be required.

Some cases are met with presenting a more formidable difficulty; as, for example, when the root is situated behind the circle of the other teeth. In a case of this sort a different kind of tooth and an entirely different course of procedure are necessary. After having prepared the root, an impression of the parts is taken in wax, from which a plaster model is obtained, and from this two metallic dies. With these a gold plate is to be swaged, extending backward so as to cover the root, and forward to form a line with the outer circle of the teeth. To the posterior part of the plate covering the root, and directly beneath the cavity in it, a gold pivot about three-eighths of an inch long, is soldered, and to the anterior part of it a plate tooth of the right size, shape, and shade is attached. A hollow gold

screw is now introduced into the root, and into this the gold pivot is inserted; or the post may be attached to the root with zinc cement. A right superior central incisor mounted on a plate with a pivot, for insertion in the manner here described, is represented in Figs. 626 and 627.

FIG. 626.

FIG. 627.

A method of inserting an artificial tooth on a metallic pivot is described by the late Dr. James B. Bean in Vol. III, 1869–70, of the *American Journal of Dental Science*: "Having filed or sawed off the remaining portions of the crown, the exposed surface of the root is smoothly filed to within one-half or one-fourth of a line below the margin of the gum, giving it a slight concave appearance, so as to accommodate the neck of the *plate tooth* which is to rest against it. It is well at this stage of the operation to stop the canal loosely with a pellet of cotton or floss silk saturated with spirits of camphor, and to dismiss the patient for two or three days. If no inflammation be present, the canal may then be cleaned out and carefully filled with gold foil from the apex to within four or five lines of the orifice.

"The remaining portion of the canal not filled should now be enlarged to about one line in diameter, if the size of the root will admit of it, down to the gold filling, making the bottom smooth and solid and the sides parallel. The orifice, to the depth of nearly a line, is again enlarged with a bur-drill to about two lines in diameter, and a small groove or undercut is formed around the margin for the retention of the gold filling subsequently to be introduced around the tube.

"Hollow gold, jeweler's wire, or simple gold tubes made of gold plate may be employed. If the latter is chosen, it is formed by bending a piece of ordinary gold plate around a wire, so as to form a cylinder sufficiently large to fit the smaller portion of the canal prepared for it; then solder with the finest gold solder. A piece of the tube half an inch in length should be cemented with shellac into a hole bored through a piece of wood half an inch in thickness, to serve for a handle; the interior is then carefully dressed out with a jeweler's broach which has a slight taper, making it smooth and regular within. A solid gold wire pivot is now carefully filed and fitted by grinding it with fine emery and water, making a 'ground joint,' whereby the pivot is firmly held when in place. Any portion of the wire that may project beyond the smaller end of the tube should be cut evenly off, while at the larger end it should project at least one-fourth of an inch.

"The tube must be taken out of the cement and a piece of plate

soldered to the smaller end, forming a *bottom*. An easier flowing solder should be used for this, so as not to disturb the first. This tube thus formed, after being cleansed in acid and smoothly filed, is ready to be inserted into the root.

"Some have proposed to cut a screw on the tube, whereby it is firmly secured in its place, and to fill then around with gold. But the most convenient way is to cut a number of barbs with a sharp knife, on the outside, looking toward the open end; this retains the gold in place nearly or quite as well as the screw. Being made so as to enter the root rather loosely, several folds of gold foil are wrapped around it, and after carefully drying the parts with bibulous paper—the pivot being in its place in the tube—the whole is forced to the bottom of the cavity and the loose portions of foil removed; zinc cement may also be used to secure the tube.

"Another method is to fill the space around the tube with gold. The gold pivot is now removed and the tube carefully sawed or filed off nearly level with the end of the root, and the surface of the gold and the root well polished.

"Thus far we have the root preserved with a good filling, and a gold tube firmly secured in it containing an accurately fitting gold pivot.

"The next operation is to attach a suitable tooth to the pivot, and for this purpose a plain plate tooth is selected that will be suitable in size, shape, and color. This tooth should be so ground and fitted to the anterior edge of the root that the free margin of the gums will cover the point of union. Then, after soldering a strong backing to the tooth, it is fitted to its position, with the gold pivot in place, on which has been soldered a small shoulder or ring of plate, and the projecting portion of the wire cut off. This shoulder is to be made in the form of a disc, cut out of gold plate, larger than the diameter of the pivot, then perforated with a hole just large enough to admit the pivot up to the point, a little less than the depth of the tube. Being retained at this point, it is made to fit closely down on the root; the whole is then carefully withdrawn and bedded up to the ring in plaster and asbestos, thoroughly dried, the wax removed, and the piece soldered with fine solder. If the ring is loose, it must be kept in place by wax or plaster in the act of withdrawing it from the tube. The pivot is again tried in the mouth and, if satisfactory, the projecting portion is cut off, smoothly filed, and the tooth attached to it with shellac; then try in the mouth, and alter its position if necessary. If the pivot does not fit too tightly, the whole can be withdrawn together, carefully invested in plaster and asbestos, and strongly soldered. The piece is now finished up, reducing the shoulder around the pivot to less than half a line in breadth; a large plate covering

the end of the root has no advantage, and would only form a lodgment for food and the secretions of the mouth, inducing decomposition and the destruction of the root.

"If the pivot is not retained sufficiently firm in the tube, it may be wrapped with a few fibres of floss silk or cotton, and when forced into its place with a slight rotary motion it will remain quite firm, and can be used with great satisfaction. If the adjustments have been properly made, the shoulder or flange will fit closely on the edge of the tube, the neck of the tooth resting on the beveled edge made for it, thereby preventing the tooth from turning on its axis. Proper care and cleanliness, removing the tooth at least three times a week, will enable such a piece to be used with satisfaction for many years."

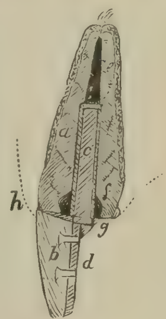


FIG. 628.

Fig. 628 represents an antero-posterior section of a superior central incisor root pivoted in the manner above described. *a*, dentine of root; *b*, porcelain tooth; *c*, pivot surrounded by the tube; *d*, backing, which is soldered to the tooth and to the pivot; *e*, filling between the end of tube and apex of the root; *f*, filling around the tube by which it is retained in place; *g*, flange resting on the edge of the tube; *h*, junction of the tooth and root, concealed by the margin of gum.

Another method for inserting an artificial crown on a metallic pivot is that of Dr. T. J. Thomas, by which the end of the root is protected from the action of deleterious agents and a firm support given to the tooth. It is thus described by Professor Gorgas:—

"Prepare the tooth as for an ordinary pivot; then select a *plate tooth* of the proper size, shape, and shade, and fit it by grinding accurately to the prepared root.

"After this is done, enlarge the pulp canal by reaming it out as large as the root will permit; that is, make a conical-shaped cavity in the exposed surface of the root, allowing the margin of this cavity to be quite near to the periphery of the root, with slight undercuts or retaining points on the anterior and posterior walls.

"After this cavity is prepared, and that portion of the pulp canal beyond it filled to the apex of the root with gold, make a square metallic pivot of twenty-carat gold alloyed with platinum, in the proportion of five parts of gold to one of platinum. This pivot is made in two parts, which are soldered together at the base of the artificial crown and slightly wedge-shaped. After the pivot is prepared, a thin piece of platinum plate is bent around it, thus forming a square cylinder into which the pivot perfectly fits. The pivot is then carefully

drawn out of the square cylinder, and the edges of this cylinder soldered with pure gold. The pivot is again inserted, and the excess of solder and any rough edges which may be found in the cylinder filed off.

"After this is done, the cavity in the root is carefully dried and protected from moisture, and the square cylinder, with the pivot inside of it, is placed in the center of this cavity, which is filled around it with gold in as careful and perfect a manner as any crown cavity, or secured by zinc cement. The gold, or the cement, is allowed to overlap the margin of the cavity, so as to perfectly protect all of the exposed—or what, in the ordinary method, would be the exposed—surface of the root.

"The gold filling, or cement, besides protecting the root, retains the square cylinder in the center of it. In placing the cylinder in the root with the pivot in it, preparatory to inserting the gold filling around it, if gold is used to secure the cylinder, the split in the pivot should range directly back from the labial to the palatine surfaces, and not transversely. The pivot, after the filling is inserted, is drawn out of the cylinder, which remains firmly fixed in the root, and that part of the cylinder which projects beyond the gold is filed down to a level with the surface of the filling. An impression of this surface is then taken with wax or gutta-percha, and die and counter die made of fusible metal, by means of which a disc of platinum plate is swaged to fit accurately the concave surface of the gold filling in the root.

"When this is done, the convex surface of the disc is thinly covered with wax, and the disc placed in its proper position over the gold filling in the root, and slightly pressed on it, in order to obtain an impression of the square orifice of the cylinder, by which a hole corresponding in shape and position may be cut in the disc. The outer end of the pivot is then inserted in the square hole made in the disc, secured by means of wax, and the whole returned to the root (with pivot in the cylinder), in order to make certain that the pivot is in its proper position; then it is carefully removed and secured by an investment of plaster and asbestos, that the pivot may be soldered to the disc.

"The projecting portion of the pivot above is filed down to a level with the concave surface of the disc, and the disc and pivot returned to the cylinder in the root, when the plate tooth is placed in position and secured to the disc by means of wax.

"This done, the pivot, disc, and the plate tooth are carefully removed and invested in plaster and asbestos, in order that a backing of gold may be made, and the tooth soldered to it and the disc. The tooth is now ready to be inserted, and by slightly separating the two parts which form the pivot, at its apex or free extremity, it will tightly

fit the cylinder, the two halves acting as springs, and pressing against the walls of the square cylinder inserted in the root."

The late Dr. M. H. Webb suggested several methods of pivoting by which gold crowns with porcelain faces made of plain plate teeth are attached to natural roots.

One of these methods consists in soldering to a plain plate tooth with straight pins a narrow strip of heavy gold plate beveled on its sides toward the tooth, and long enough to form the pivot extending into the root.

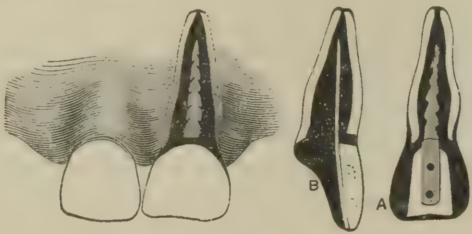


FIG. 629.

When ready for insertion, gold is packed around the pivot (being anchored in the roots by means of undercuts) and behind the beveled edges of the backing, and so built up as to form a contour palatine surface on the crown (Fig. 629).

Another method of Dr. Webb's is to back with gold plate a plain plate tooth with straight pins, the sides of the backing being bent to form a tube or cannula. Through this tube a gold pivot passes into

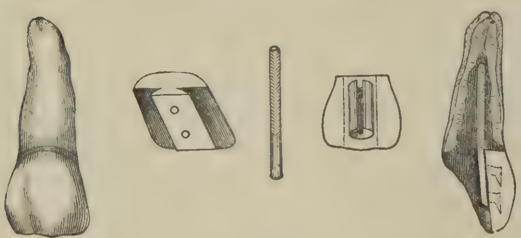


FIG. 630.

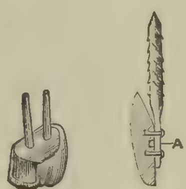


FIG. 631. FIG. 632.

the root, and cohesive gold is employed to secure the pivot to both crown and root, by packing it around the pivot in the root, around the tube on the backing, and into the dovetailed grooves in the crown (Fig. 630). This plan is a modification of that suggested by Dr. W. H. Dwinelle, to be used in connection with crystal gold.

A method of no recent date is, to take an impression of the root surface and adjoining teeth, and to drill a hole in the plaster model thus obtained, to correspond to the canal or canals of bicuspids and

molars. Into these holes gold, platinum, or platinum-and-iridium alloy pins are inserted, and to these a disc covering the exposed surface of the root is soldered. A plate tooth is then adapted by grinding and soldered to the disc, the plaster model serving as a guide for the adaptation of both pins and crown. Fig. 631 represents the tooth prepared for insertion into the root by means of gutta-percha or zinc preparations, the pins being roughened or barbed, being made square for the latter purpose. When the roots are filled with gutta-percha, the pins and crown are warmed and pressed into place.

Dr. J. F. Flagg suggests the following method of pivoting, shown in Fig. 632, and described by him as follows: "Select plate tooth, fit it to root, and bevel it from near the pin—cervical—or pins, if cross-pins, to the labio-cervical edge. Solder a platinum pin to it as a backstay and pivot combined, leaving it rough or grooved on both sides of the pin for a retaining hold to the finishing palatal amalgam.

"Fill the root . . . . I prefer to give this ('cement') a day to harden thoroughly. In the root filling drill a hole larger than the platinum pin, as near to the palatal portion of the filling as possible, and directed slantwise to the apical center of root-filling; then fissure-drill the hole toward the labial side of the now *oval* pivot hole. By this method the tooth is accurately placed in position, and easily held firmly in place while the pin is secured by filling the pivot hole with amalgam. Let this harden for half an hour, and then add amalgam in contour to the root-filling and palatal face of the porcelain tooth. It is at this point of the operation that the need for 'beveling' the cervical portion of the tooth is demonstrated, for by this bevel one is enabled to make, by filling, a perfectly tight joint at the labio-cervical junction of tooth with root, and also to secure a strength of amalgam equal to the entire surface of root-filling."

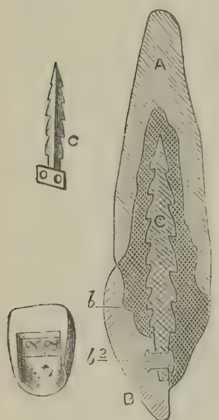


FIG. 633.

Dr. Boice modifies Dr. Flagg's method by cutting a groove across the tooth between the pins before attaching the platinum pivot, for the purpose of leaving a space behind the pivot for the better support of the amalgam with which it is filled.

Dr. H. Weston's method consist of a special crown with a depression on its palatal surface, within which are the tooth-pins and a spear-shaped pivot of hard platinum, or platinum-and-iridium alloy, notched on both edges, to the crown end of which a backing of the same metal

is soldered, giving the pivot with the backing (which is to be soldered to it) a T-shape (Fig. 633). The root canal being enlarged and undercut with a wheel-drill, and the crown fitted to the root and pivot, the latter is secured in the root by the packing around it, either amalgam, gold, or zinc preparation.

Dr. E. L. Hunter's method consists in making a pivot of gold alloyed with platinum, with a thread cut on one end, by means of which it is screwed into the root canal, the other end of the pivot being split. Several screws are inserted into the root around the pulp canal, to afford anchorage to the gold which is packed about them and the pivot projecting from the canal. A pivot crown being adapted to the root surface, the split end of the pivot is sprung open and the crown forced to its place, being firmly held by the split end of the pivot

Dr. G. P. Carman modifies Dr. Hunter's method by using an ordinary pivot crown, with the hole drilled completely through it (Fig. 634).

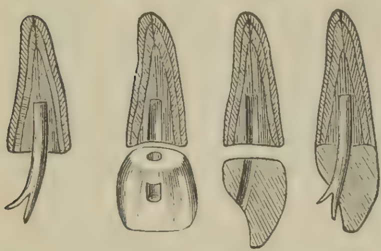


FIG. 634.

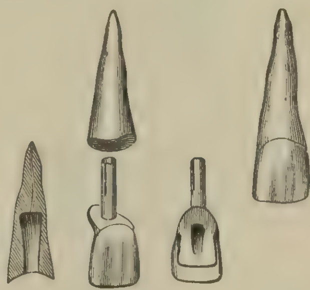


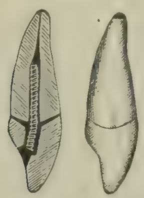
FIG. 635.

The split or cleft end of the pivot is made to fit loosely in the hole in the crown, so that gold may be packed around it to hold the crown firmly.

A method of pivoting devised by Dr. H. K. Leech (Fig. 635) is described also by Dr. Dexter, as follows: The root is drilled out to a depth of about three eighths of an inch, to a diameter of No. 16 standard American wire gauge, the bottom of the hole being flared or enlarged and the canal above filled with gutta-percha. A gold tube is made to fit the hole accurately and project sufficiently for convenience of handling, and is soldered through a hole in a gold base struck to the root, projecting through the plate some distance. A plate-tooth is fitted to the root and plate and soldered to the latter, gold being flowed on to the plate and backing and around the projecting tube, to form the palatal contour, and the tube cut off flush with the latter. We now have a plate tooth, gold backed, with a tube pivot,

the orifice of which opens on the palatal aspect of our tooth. The root end of the tube is now slit perpendicularly in three or four places, for about two-thirds of its length, a thin sheet of warm gutta-percha is placed on the base of the crown around the tube, and the whole is pushed securely to place. Now pack gold or tin into the tube, *condensing the bottom portions so that the slit end will spread and tightly fill the flared end of the hole in the root,* and the operation is complete. Dr. Dexter suggests that tin be used to fill the tube, so that the tooth may be easily removed in case of trouble.

Dr. W. G. A. Bonwill, the inventor of the "Bonwill crowns," has suggested several methods of pivoting, but the latest, consisting of an all-porcelain crown, he considers to be the best. These teeth are made in special molds, and the incisor crowns are so shaped as to form a dovetail, which allows the strain outward to come high up near the cutting edge, and not to depend upon the palatal wall for support. The bicuspid and molar crowns are cut out at the base, leaving little more than a shell with undercuts for the amalgam, to act as dovetails, the operation being an amalgam filling capped with porcelain. The hollow crowns enable the operator to fit them to the natural roots very readily, as there is little material to grind off.


Mounted Crown.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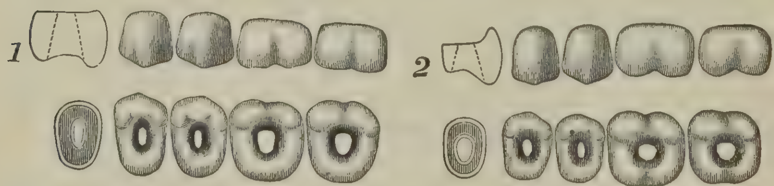


FIG. 636.

After the crown is fitted to the root the pulp canal is filled with amalgam in a plastic condition, and the triangular barbed metal pin is forced into it. The crown is then filled with the same substance, placed over the pin, and forced to its place, the pin resting in the hole in the crown. Several modifications of this method are suggested by the inventor, such as a nut on the end of the pin, and a gas vent formed by allowing a flat side of the pin to rest against one wall of the canal, and the space kept free of amalgam when it is packed about the pin. Retaining points are made in the root with a wheel bur, and the amalgam is packed in the countersunk base of the crown, and

the surplus escapes by the opening on the palatal surface in the case of an incisor crown. When the crown is well pressed into its place on the root, the amalgam can be packed in around the pin. The too free escape of the amalgam through the palatal opening in the crown can be prevented by placing the thumb and index finger on the orifice when pressing up the crown. The tooth should be kept at rest until the amalgam has hardened. Fig. 637 represents the Gates-Bonwill

FIG. 637.

crowns, which are inserted on the triangular pins in the same manner as the crowns just described.

Dr. S. Davis's method (Fig. 638) is to prepare the root as usual, and ream out the chamber in a funnel shape, and cut anchorages in the sides of the reamed surface. A plate-tooth is then fitted, by grinding it, to the labio-cervical edge of the root, and backed with gold plate, when the sides of the tooth and backing are ground to bevel sharply inward, leaving the labial surface untouched. A gold pivot is then soldered to the backing, of such a length that when it is placed in position a narrow space is left between the crown and root. The pivot and backing are then roughened, the latter being barbed and fastened into the root with oxychlorid or oxyphosphate of zinc. Gold is then packed in the retaining points, the pulp chamber and around the pivot, and built upon the backing to give a proper form to the inner surface of the crown of the tooth.

The four-pin crowns, invented by Dr. W. Storer How, are among the more recent methods of pivot work, and the following description of the successive steps to be taken in mounting these crowns, with the necessary appliances, was prepared for the present edition of this work by Dr. How.

1. When the root is in proper condition for mounting, measure the depth of the canal by means of the canal plugger (Fig. 640) and its flexible gauge (Fig. 639), and fill the canal at and a short distance from the apex of the root, keeping the gauge at position to show the length of the canal, and also the distance to which it has been filled.

2. Cut off the root crown, with the excising forceps and a round file, down to the gum margin, and with the barrel bur, No. 241, cut the labial part of the root fairly under the gum without wounding it.

3. Set gauge (Fig. 639) on a Gates drill (Fig. 644), to one-half the gauged depth of the canal, and drill to that depth.

4. Set the twist drill (Fig. 643) in its chuck (Fig. 647), to project the same length as the Gates drill, and, turning the chuck with thumb and finger, drill the root to exactly that depth.

FIG. 638.

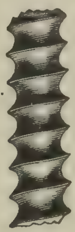


FIG. 641.

FIG. 642.

FIG. 643.

FIG. 639.

FIG. 645.

FIG. 646.

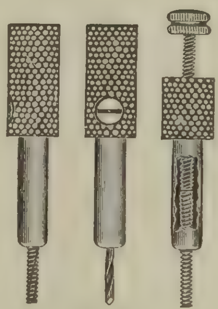


FIG. 647.

FIG. 640.

FIG. 644.

5. Enlarge the mouth of the canal, one-sixteenth of an inch deep all around to near the margin of the root, using the square-end fissure

bur, No. 59, and then with the oval, No. 94, under-cut a groove at the sides and lingually, as shown in Fig. 645.

6. If the rubber dam is to be used for a gold or plastic backing, put it now over the root with Hunter's root-clamp, also over the adjacent teeth, and thoroughly dry the canal.

7. Set the tap (Fig. 646) in its chuck (Fig. 647), a trifle less in length than the drill; oil the tap and carefully tap to the gauge depth.

8. Insert the post in its chuck (Fig. 647) to the exact gauge of the tap, and turn the thumb screw down hard on the end of the post; then screw the post into the root; release the thumb-screw; unscrew the chuck a half turn; bend the post until the chuck stands in center line with the adjoining teeth, and unscrew the chuck.

9. Slit the rubber back from adjacent teeth, tucking the flaps out

Fig. 648.

Fig. 649.

Fig. 650.

Fig. 651.

Fig. 652.

Fig. 653.

Fig. 654.

of the way, so that occlusion may be tried, and the post excised and ground off, until the teeth close clear of the post.

10. Try the crown on the post, and with an F disc, *dry*, grind the rib between the neck-pins until the crown is labially flush with the root margin, cutting a little at a time until exactly flush.

11. Take the crown and place the mandrel (Fig. 648) between the pins just as the post is to be, and, with the pliers (Fig. 649), bend the pins carefully over the mandrel, cutting off the pins if too long to be pinched in on the mandrel at the sides, observing that the pin nearest the cutting edge is first to be bent (Fig. 651), and the opposite pin bent *below* it on the mandrel, and so with the others (Fig. 652).

12. Slip the crown over the post, try occlusion, and with the post-chuck bend the post until the crown is properly aligned with the teeth; then with a stump corundum wheel No. 3 grind the neck of the crown to a close labial fit with the root, fitting only the portion to be concealed by the gum, leaving narrow gaps at the sides to be filled by the backing between crown and root (Fig. 653).

13. Grind the cutting edge for relation to the other teeth, being sure that the opposing tooth does not strike crown, or post, or pins.

14. Fix the crown on post by pinching the pins into the screw threads of the post with special pliers (Figs. 649 or 650).

15. Finally, pack the backing of gold, or cement, or amalgam, or Wood's metal, or—for temporary backing while treating abscess—gutta-percha, into all the crevices around the post and behind and under the pins, and between the crown and the root; contour and finish thoroughly, so that no ledge or other imperfection can be found.

Fig. 654 shows in vertical mid-section an incisor crown mounted; the blackened portions of the backing defining the locking-hold of the backing on the post, the crown-pins, and the root recess.

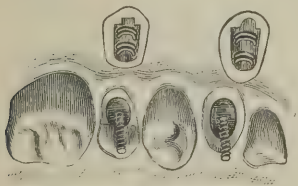


FIG. 655.

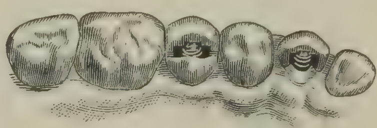


FIG. 656.

Fig. 655 shows in perspective a cuspid crown ready to be slipped over its post, and also a cuspid crown ready for its post in the bicuspid root, which has its lingual cusp remaining, and Fig. 656 shows the crowns on their posts awaiting the contour-backing.

In mounting a crown on the bicuspid root (Fig. 655) the chucks will not usually pass the natural cusp, and hence the drill and the tap must project the cusp's length in addition to the gauge length. Observe also if the space between the tap and the cusp is wider than the thickness of a crown-pin, and, if not, cut the cusp vertically with a large fissure-bur, so that the space shall be wide enough, before setting the post, else the bent pins will not pass between the post and cusp. Grind the rib—see step 10—quite down to the floor of the crown; take steps 11, 12, and 13, and, if the occasion necessitates grinding the crown so as to destroy one pair of pins, invest the crown, and older the pins at the lap, taking step 15 for completion.

When it is desired to contour the backing of a cuspid crown to

form an inner cusp, or to adapt a cuspid or incisor crown for masticating uses, the pins may be twisted together over the mandrel, and again twisted tightly over the post, as in Fig. 657; but in some cases it may be better to bend the neck-pins, as in Fig. 658, instead of twisting them. In all cases the bent pins are to be pinched quite hard over the mandrel and post, so that the serrations of the pliers will roughen the pins to prevent their being pulled through the backing, which should also be condensed around the pins and post.

If the root is not ready for permanent mounting, use a tubular post, or, in the absence of a threaded tube, take the successive steps up to 13; then back temporarily with wax, rubber, or gutta-percha, awaiting the next sitting, when the crown may be taken off, the post unscrewed, and the remedy applied. Thus the root may be alternately medicated and mounted until ready for the permanent crown.

When the root is much decayed, the bottom of a cone-shaped

Fig. 657.

Fig. 658.

Fig. 659.

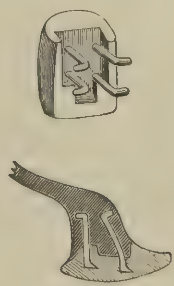


Fig. 660.

cavity may be drilled and tapped to the depth of a sixteenth of an inch, and the post, thus anchored, may be further secured by cement in the grooved walls of the cavity and around the post (Fig. 659).

These crowns afford unusual facility for mounting by any of the well-known methods of inserting the post after soldering it to the crown. They are also adapted for use in celluloid and rubber work, especially in cases of single teeth. The several long pins, having their ends bent with pliers at a sharp angle (Fig. 660), may be so arranged as to both strengthen the shank of the plate and hold the crown very firmly in position.

The screw-posts are made of crown metal, an alloy devised for the purpose, in order to obtain a stiff post that will permit the cutting of the peculiar and extremely accurate thread formed upon it, and which will not amalgamate or be otherwise affected by any backing material that may be used. Of course, platinum or platinum alloyed with

iridium may be employed for posts, but the crown metal is in every way superior.

There are some cases of a class which has hitherto presented difficulties that may now be easily overcome by grinding the post flat on the crown side after it has been set and bent in the root (Fig. 661),

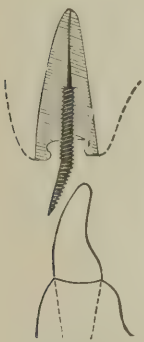


Fig. 661.

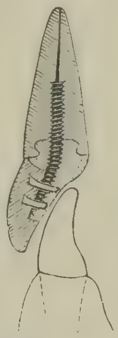


Fig. 662.

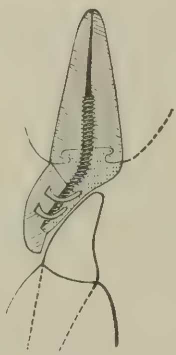


Fig. 663.

Fig. 664.

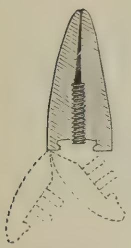


Fig. 665.

so as to be clear of the occluding tooth; and then the crown-pins may be bent over the reduced post, the crown fitted and ground to clear the opposite tooth (Fig. 662), and the backing added.

A similar case, in which the opposing tooth and a proper alignment require an oblique bending of the pins, is seen in Fig. 663, while the reverse arrangement of parts is shown in Fig. 664. The crown is thus seen to be adapted to a wide range of adjustments because its point of contact with the root is at the labial portion of the neck, on which, as on a hinge, the crown may be swung out or in (Fig. 665, dotted lines), over an arc of at least sixty degrees, at any point of which it may be quickly and firmly fixed. The labio-cervical

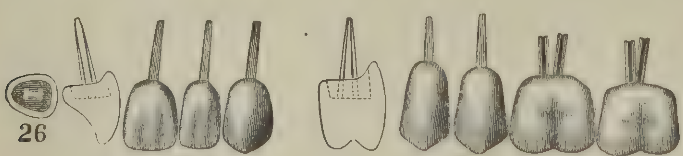


Fig. 666.

junction is made just under the gingival margin, with a thin layer of cement, amalgam, or gutta-percha, or a narrow ribbon or several large blocks of soft gold interposed; the joint always to be made smooth, and hid from view under the free margins of the gums.

Dr. M. L. Logan has devised a porcelain crown, with a metal pin placed in position before burning the tooth (Fig. 666). The pin extends three-eighths of an inch outside the crown, which is provided with a basal cavity intended to be filled with a cement or other retaining material, to afford additional support.

Fig. 667 represents posterior Logan crowns, where the pin, in the incisors, cuspids, and bicuspids, is a stout, tapering, double-T-shaped platinum post, which extends outside of the crown three-eighths of an inch. It can be split, as shown, for two-rooted bicuspids, or shortened when necessary. The molars are made with two square pins, grooved on all four sides. One of these is for the palatal root, the other for either of the buccal roots, as may be most convenient. The posts can be filed smaller for special cases, or nicked, if desired, to afford a stronger hold in the retaining material, though this will usually be unnecessary, as their shape was designed specially to give the strongest hold possible. It can be used with the seamless gold collars when desired.

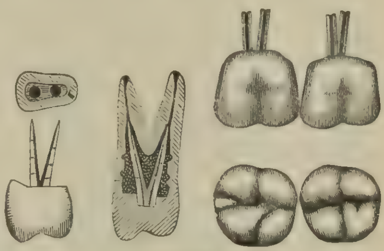


FIG. 667.

For reaming out and grooving the walls of the root-canals, Fig. 668

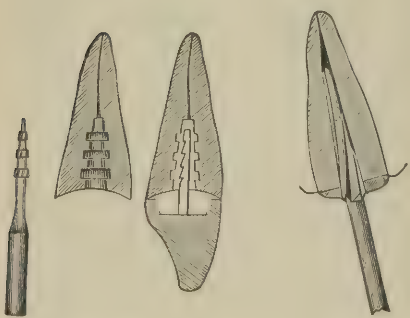


FIG. 668.

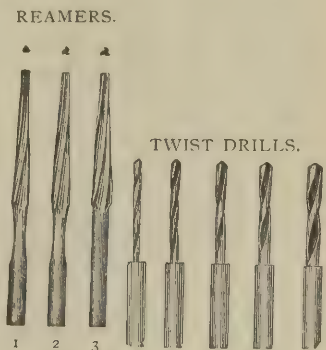


FIG. 669.

represents what is known as the "grooving bur engine-bit." This bur is intended for cutting grooves in the walls of root-canals to provide retaining-points for plastic materials in setting porcelain crowns. The grooves are made by sweeping the bur, while in motion, around the walls of the canal, which should be made large enough to permit the bur end to reach the bottom of the cavity. Two or three grooves,

as may be desired, can be cut in thin roots with safety, one size of the bur answering for all cavities. The canal is then filled with gutta-percha, oxychlorid, amalgam, or other plastic, and before it sets the barbed pin of the crown is inserted, with the effect of forcing the material into the grooves, thus adding greatly to the strength of the operation.

Fig. 669 represents twist drills and root-reamers.

Fig. 670 represents Dr. Ottolengui's root-facers, and Fig. 671 represents corundum points for dressing and beveling roots.

The root-reamers are of the size and taper of the Logan crown-pins Nos. 1, 2, 3, and have corresponding numbers. With a drill just the diameter of the smooth end of the reamer, the root should be drilled to the proper measured depth and the bored canal be then enlarged

ROOT-FACERS.

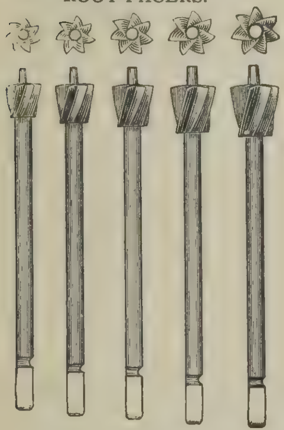


Fig. 670.

ROOT-DRESSERS.

1 2 3

Fig. 671.

Fig. 672.

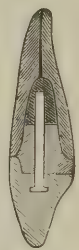


Fig. 673.

with a suitably numbered root-reamer, which, having a smooth end, cannot be forced beyond the end of the drilled hole. There are five sizes of the root-facers, so that one may be chosen of such width that the root end can be smoothly, quickly, and safely faced to fit the crown.

Dr. R. Ottolengui's method of mounting the Logan crown is as follows: "The canal of the root to be crowned is opened up to the proper depth with a twist drill, and then with a root-reamer corresponding to the size of the pin, is enlarged to fit the pin along its whole length, and so hold the crown firmly *independently* of the cement. With a root-facer a labial slope is given to the root-end, so that the crown neck shall fit under the edge of the gum. The cuts (Fig. 674) show the method and its result, and the cross-section shows how the cement encases the pin.

"The distinguishing excellences of this crown are the ease with which it can be set and the naturalness and strength of operations made with it. The crown is hollowed out around the pin so that when mounted the retaining material extends inside of the crown instead of forming a joint at its junction with the root, thus carrying the line upon which the leverage is exerted nearer to the point upon which the biting force is applied, and providing room for a considerable body of the retaining material instead of a thin disc as

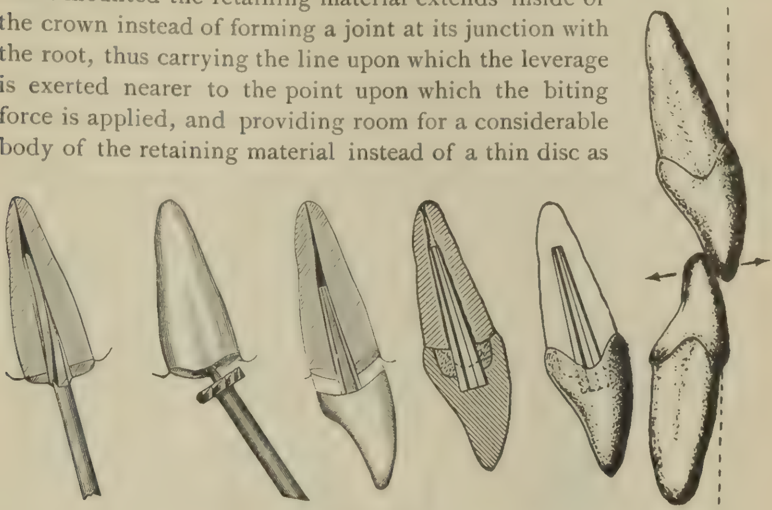


FIG. 674.

in ordinary crowns, reducing the liability to fracture to the minimum."

Fig. 675 shows an enlarged platinum pin, and also a cross-section of a central incisor, giving the position of the pin in the root.

Dr. Gordon White's method of adjusting a Logan crown to a natural root is as follows:—

"By making a considerable change in the present form of the Logan crown, as shown in Fig. 676, A and B, we have a crown that can be adjusted in a few minutes, and with a degree of perfectness not yet obtainable by any crown on the market, nor, within my knowledge, by any so far suggested method.

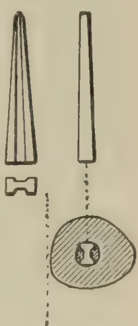


FIG. 675.

"The manner of making the adjustment is certainly as simple as could be desired.

"After preparing the canal for the reception of the 'Logan-pin' select a tooth in the usual way, having regard to correct length, width and color, and if care has been exercised to select one as near the right length as possible it will only be necessary to touch the buccal or labial point of the neck of the crown a few times with the corundum wheel, and the proper length or bite will be obtained. Next take a disc, or small piece of

thin platinum foil, about No. 50, and push through this the pin of the tooth, carrying the disc up against the porcelain, as represented in Fig. 677. With a little drop of Parr's fluxed wax dropped in the triangle, as it were, formed by the backing and the pin, the disc is held securely in place, and the platinum is trimmed around with small scissors, that there may not be any overlapping. Now place around the pin on the platinum a ball of Parr's wax, stick the pin through the second disc of the foil, and rub the platinum with a hot instrument, that the wax and disc may be sealed together, as shown in Fig. 678. Place this in ice-water to harden the wax, so as to resist pressure. It is now ready to insert, and by pressing the tooth up until the labial surface strikes the end of the root, and having the patient to close the jaws, the correct bite will be secured with the opposite tooth. It will be found on the removal of the crown, that the platinum next the root has been perfectly swaged to the root-end. The second disc is now trimmed according to the outlines of the root. When it is so desired, the palatine side of the root having been left a little high, or just above the

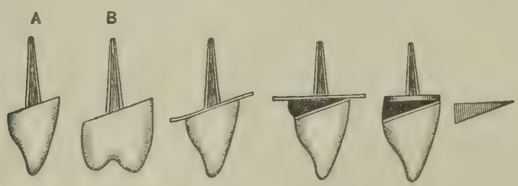


FIG. 676. FIG. 677. FIG. 678. FIG. 679. FIG. 680.

gum, the platinum can be split with scissors, lapped, and burnished around the exposed side of the root, to form a partial band (Fig. 679).

"After having dried the wax with bibulous paper, and shaped up the approximal sides, these sides are covered with small, triangular pieces of platinum (Fig. 680), by laying the platinum on the wax and rubbing over it a hot burnisher. The crown is now ready to invest, and the investing mixture is poured on a small piece of wire netting, which will prevent its cracking during the soldering operation. The wax having been burned out, this triangular box is filled flush with solder in the usual way and polished. The result is a beautiful and perfect crown, in every respect the most substantial porcelain crown we have."

Dr. E. C. Kirk's method of fitting the same style of crown is as follows:—

"The following method will in the majority of cases enable a perfectly close joint to be made between the crown and root-end. Cut several small pieces, about one-quarter inch square, from a strip of thin articulating paper. In the center of each punch a hole with the tool shown in the margin. Having prepared the root-end, slip the

perforated piece of articulating paper over the pin of the Logan crown and press it firmly into position, in contact with the root. Upon withdrawing the crown and removing the articulating paper, the points of contact will be found to be marked black. Grind these off carefully, readjust on the root as before, grind again, and continue the operation of fitting and grinding until the mark made by the articulating paper on the contact surface of the crown presents as a uniformly unbroken black ring. When this has been accomplished, the crown will be found to fit the root-end with the utmost accuracy. The advantages of fitting a crown directly to the root are, it would

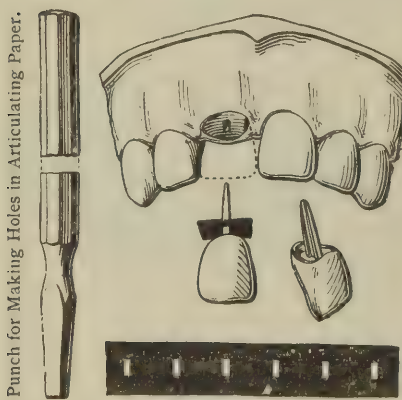


FIG. 681.—Prepared Articulating Paper.

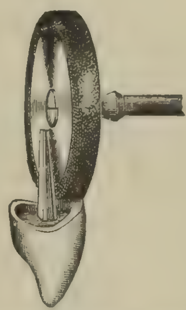


FIG. 682.—The above figure shows the Operation of grinding the Crown to fit the Root.

seem, self-evident from the mechanical standpoint, and involve beside the least expenditure of time."

Another method of fitting the same crown is as follows:—

"After preparing the root for the reception of the Logan crown in the usual manner (Fig. 683), take an impression of the end of the root and surrounding parts with the proper quantity of moldine in a partial impression tray (Fig. 685). Remove the impression carefully and fill it with Melotte's metal. The location of the root canal will be clearly indicated by a small hole in the metallic model (Fig. 684), and this hole may be deepened with a twist drill and slotted or elongated for the reception of the crown pin with an Ottolengui reamer. This gives a metal root,—the exact counterpart of the natural one and adjacent teeth,—by which the crown may be fitted."

Dr. T. P. Hinman's method is as follows (Fig. 686):—

"First prepare the face of the root to be crowned as desired (Fig. A), and having selected a suitable crown (Fig. B) bend the pin, if necessary, so as to make a proper alignment.

"Next place a piece of paraffin wax around the pin next to the porcelain (Fig. C), then take No. 60 tin foil and trim a disc a little larger than the abutment (Fig. D), pierce the center of disc with the crown-pin or instrument shown in margin (Fig. E), pushing disc down until it touches the wax, place crown on the root, and force it to place (Fig. F), the wax driving the tin-foil disc to a perfect apposition with the abutment of the root.

"Remove crown with the wax holding the tin-foil disc in position, and with a pair of sharp-pointed scissors snip the edges of disc slightly all around. Place a small pellet of wax on end of pin (Fig. H), then insert pin up to the porcelain in quick-setting plaster (Fig. I); after plaster hardens warm crown and remove it, the snipped edges of disc

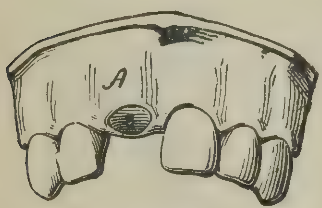


FIG. 683.

FIG. 684.

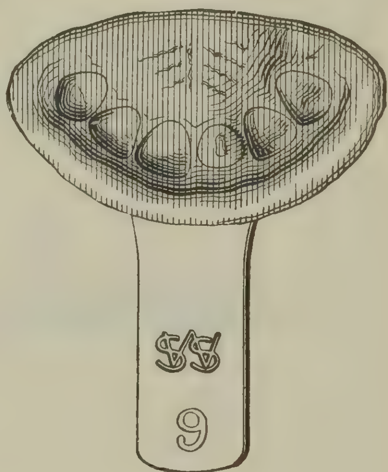


FIG. 685.

serving to hold it in position; clean off wax and replace crown on model, and you have a perfect metallic-surfaced model of the abutment of the root to which to grind with a perfect view of every surface of the root, the wax which was on the end of the pin allowing it to penetrate the plaster as the porcelain is ground away. By this method a Logan crown can be made to fit perfectly in ten minutes and no guesswork (Fig. K). It is also applicable to bicuspids."

To mount a Logan crown with gutta-percha, the following is the method (Fig. 687):—

"First prepare and treat the pulp-canal of the natural tooth-root in the ordinary way, the canal being provided with undercuts or retaining points, and fit the crown in proper alignment with adjacent teeth as usual. Fill the cup or recess in the neck of the porcelain crown

with gutta-percha, which can best be accomplished by slipping a washer or perforated disc of gutta-percha, cut to correspond approxi-

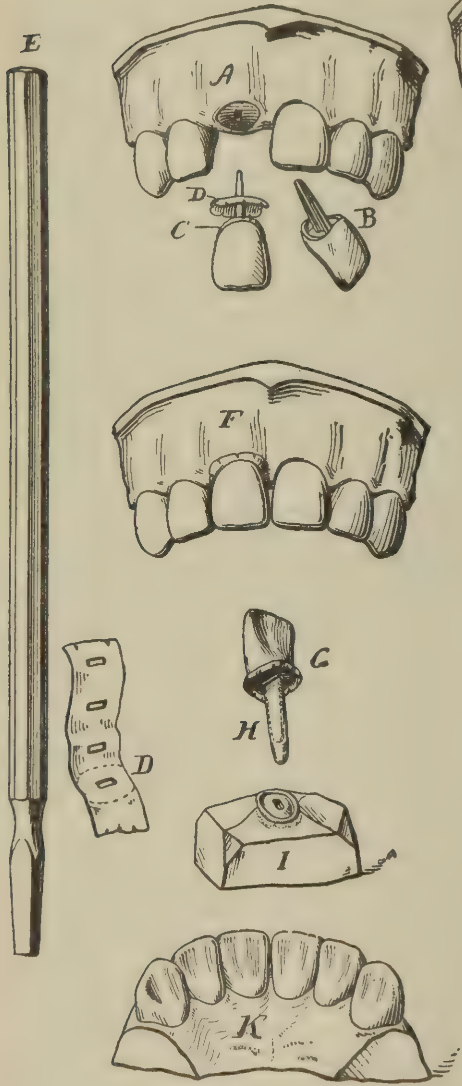


FIG. 686.

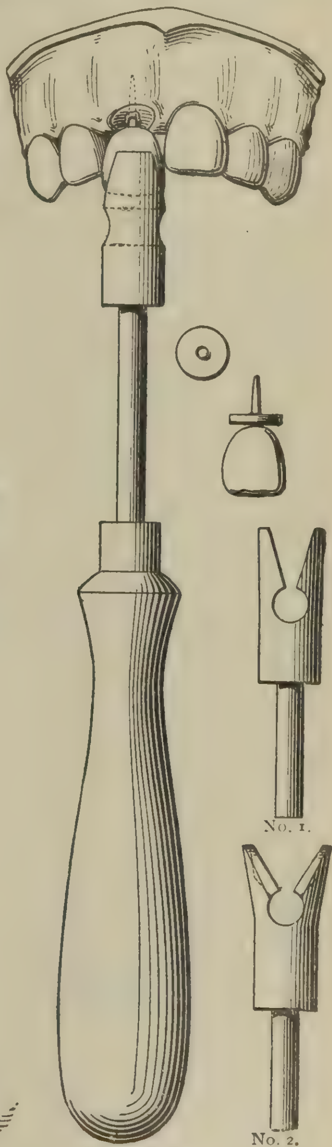


FIG. 687.

mately with the size of the neck of the crown, over the crown-pin, and after softening by holding it in the flame of a burner, press the crown

to its place upon the root. After it has been held in position until the gutta-percha has cooled, remove the crown from the root and trim off any surplus gutta-percha. Now coat the end of the root with shellac varnish, fill the root-canal with a suitable amalgam or cement, or if preferred pack it with prepared gutta-percha points, using such an amount of points as will allow the crown-pin to enter the canal quite the full length of the pin. The opening for the pin in the gutta-percha in the canal may be made with a heated instrument having a tapered point. Having packed the crown-recess with the proper quantity of gutta-percha, as above explained, place the crown in position in the mouth, heat the copper end of a crown-setter sufficiently to soften gutta-percha, and place the grooved end of the setter over the crown with the heated copper in contact with the porcelain. Hold the setter against the crown until the gutta-percha becomes soft, when pressure should be applied to the setter and the crown with its pin forced to its proper position. After the gutta-percha becomes cool, which can be hastened by dipping the crown-setter in a tumbler of ice-water and holding it against the tooth until it is cold, cut off any surplus that may be squeezed out from between the crown and root, with a sharp knife, and then with a hot tool smooth the edge of the gutta-percha between crown and root. If the cutting is attempted while the gutta-percha is soft, it will be dragged out of place.

"The use of gutta-percha for packing the root-canal, thus making the entire attachment with this material, possesses the advantage over the use of cement or amalgam, in that, should the root become abscessed, the crown may be removed with a pair of forceps after first heating it with the setter, the root-canal treated until the disease is cured, and the crown reset. Heating the porcelain crown when a cement is used to fill the root around the pin hastens its setting. Do not heat the crown if amalgam has been used.

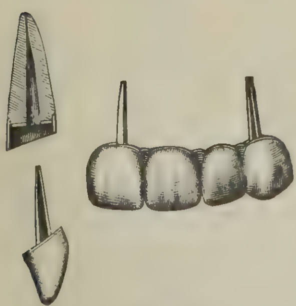


Fig. 688.

"A bridge made with Logan crowns instead of plain teeth is simple of construction as well as strong (Fig. 688). Each crown is prepared by cutting off the cervico-lingual wall of the basal cavity, and placing a packing soldered to the pin over the entire cervical end. They are then assembled as a bridge, invested in plaster and sand, the backings soldered together, and the pins, except those used for anchorages, cut off. A root for anchorage is banded and its end is covered with a plate with a hole through it for the passage of the pin."

To grind the Logan crown it is suggested to take a hollow mandrel and, while in a hand-piece, heat the end and mount on it a corundum or carborundum wheel, such as No. 00, being careful to make its outer face true, and to leave the hole in the end of the mandrel free for the post of the crown to enter. The neck of the Logan crown can then be ground without the risk of grinding the post, which enters the socket of the mandrel and is protected.

A crown has been invented by Dr. Richmond, and the mode of mounting it is described by Dr. How as follows:—

"A superior central incisor root will serve as a typical case, and its projecting end is to be shaped as seen in Figs. 689 and 690. This can be rapidly done with a narrow, safe-sided, flat, or square file, the angles of the slopes being such that the gum on the labial and palatal aspects will not interfere with nor be disturbed by the operator in this preliminary work, for the root-end is not at this time to be cut quite down to the gum. A root-reamer is then employed to bore out the root to receive the crown-post, which is of the same size and shape as the Logan crown-post for a central

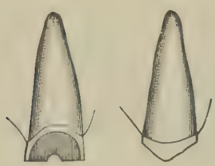


FIG. 689.

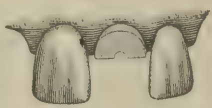


FIG. 690.

FIG. 691.

incisor. Fig. 691 shows in section the relation of the reamer to the root. The Richmond crown, Fig. 692, is then put on the root (see Fig. 693), and its position relative to the adjacent and occluding teeth noted. If the cutting-edge of the crown is to be brought out for alignment with its neighbors, the root can be drilled a little deeper and the reamer pressed outward as it revolves to cut the labial wall of the cavity. The palatal root-slope must then be filed to make the V correspond to the changed inclination of the crown.

"Thus, by alternate trial, and reaming, and filing, the crown may be fitted to the root and adjusted in its relations until the post has a close, solid bearing against the labial and palatal walls of the enlarged pulp-cavity, and the crown-slopes separated from the root-slopes by the thickness of a sheet of heavy writing-paper. This space can be accurately gauged, and the root-slopes conformed to the crown-slopes by warming the crown and putting on its slopes a little gutta-percha, so that an impression of the root-end may be taken, and the root-slopes dressed with a file until the film of gutta-percha proves to be of equal

thinness on both slopes. After thus completing the adjustment, with due attention to the alignment and occlusion, the crown and the root are to be dried as thoroughly as possible.

"To do this effectively in the root, it should first be swabbed and washed out with absolute alcohol, and then continuously flooded with warm air, until the root is not merely dry, but dried throughout as far as possible, and made so warm as to render the patient conscious of its heat. A little gutta-percha is then put on the sides of the post and over the slopes of the crown, which is then pushed into place, the exuding gutta-percha cut away, and the joint smoothed with a warm burnisher. The film of gutta-percha should be *very thin.* The crown and root may be quickly cooled by the use of the syringe with cold water, and the patient then enjoined to let the crown rest for a few hours in order that the gutta-percha may become quite set. Fig. 694 shows the completed crown.

"Dr. Richmond usually takes a thin, perforated disc of gutta-

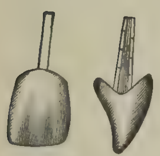


FIG. 692.

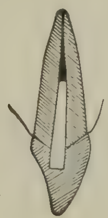


FIG. 693.

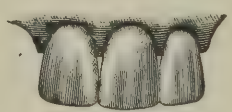


FIG. 694.

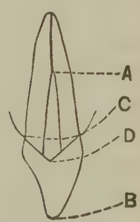


FIG. 695.

percha, pushes the post through it, warms the crown, presses it into place, and when cooled removes the crown, and with a sharp knife trims away the gutta-percha close to the crown-neck. He then warms the crown, puts a very little oxyphosphate cement on the post, and presses the crown home.

"The obvious advantages of the device are: the readiness with which the slopes of the root end may be shaped with a file; the facility with which these slopes may be given any angle to set the crown out or in at the base or at the cutting edge, or to give it a twist on its axis; the certainty that, once adjusted, the final setting will exactly reproduce the adjustment; the assurance that in use the crown will not be turned on its axis,—a most common cause of the loosening of artificial crowns; the firmness of its resistance to outward thrust in the act of biting. This fact is made apparent by Fig. 695, wherein it will be seen that in an outward movement the crown B would rock upon A as a pivot, and the dotted line D shows how the crown slope is resisted by the root-slope, which extends so far toward the incisive edge that a

much firmer support is given to the crown than if the resistance should be, as it usually is, on the line of the gingival margin C.

"The cases for which the new crown seems specially adapted are such as have some considerable portion of the natural crown remaining, and for these it would seem that no better artificial substitute has yet been made accessible to the profession.

"For roots that have become wasted below the gum-surface the new crown is not suitable, except in such cases as are decayed under the labial or palatal gum-margin only, but have yet projecting the approximal portions of the crown (see Fig. 696).

"The sectional view (Fig. 697) and the perspective plan views (Fig. 698) illustrate the manner of mounting these crowns on this class of roots. The finished crown appears as in Fig. 698."

Fig. 699 represents different forms of crowns, and the nut-driver and screw-nut for setting porcelain crowns on natural roots.

The all-porcelain crowns, such as the Foster, Gates-Bonwill, dove-

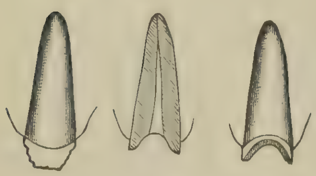


FIG. 696.

FIG. 697.

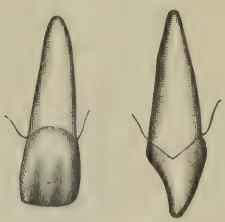


FIG. 698.

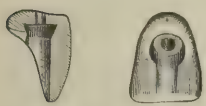
tail crown, and others, have been set in various ways, prominent among which has been the use of solid-headed screws; but we find that much more satisfactory and firmer work can be done by first fixing the screw-post in the root, thus permitting the crown to be slipped over the end of the post and properly adjusted to the root, after which the cavities in both root and crown may be partly filled and a nut screwed on the end of the post to condense the filling and firmly secure the crown in its place. These appliances are very simple. They consist of a nut-driver, over which is placed a split tube for carrying the nut (see sectional view). The sole object of this tube is to hold the nut and prevent its falling into the mouth or on the floor during the process of attaching or detaching it from the post.

The substitution of pieces of porcelain for the portions of crowns of teeth destroyed by caries, by a process of inlaying, was suggested many years ago by Dr. Edw. Maynard, and successfully practiced by

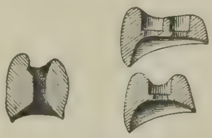
Dr. A. J. Volck, of Baltimore, and also by Dr. B. Wood. Dr. W. Storer How describes a method as follows:*—

"One of the chief obstacles to success in many of these operations has been the difficulty of exactly fitting the inlay to the tooth. There is, however, a class of cases which, by methods that will be now described, may be repaired with the certainty of gratifying results.

"A typical instance is that illustrated in Fig. 700; the filling of gold usually inserted in such a cavity is a glaring disfigurement,

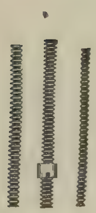


Foster Crown.

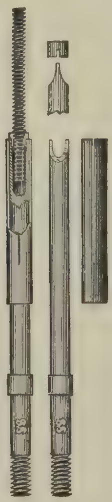


Gates-Bonwill Crown.

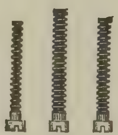
Dove-tailed Crown.



A B C
How Screw Posts
(B with nut).



Nut-Driver with Split Tube.



A B C
Headed Screws.

Fig. 699.

endurable only by reason of the necessity of preserving the life and usefulness of the tooth. Fig. 700 also shows the oval-shaped cavity about to be converted into a circular one by means of a wheel bur, as, say, No. 208. A fine-cut bur is essential for this work, which requires skill and delicacy with firmness of touch in order to the making of a truly circular cavity of the smallest diameter consistent with the inclusion of all the borders of the original cavity. When

* *Dental Cosmos*, August No., 1888.

this has been nearly done, and the cavity suitably deepened by an excavating wheel-bur, as No. 22, the barrel-bur, say No. 239, is to be used with steadiness and due attention to the holding of it, so that when pressed quite to the bottom of the cavity the margin will be exactly circular, whenever that is possible. (See Fig. 701.) In some cases the differences between the diameters of the successive or even the same numbers of the finishing burs will be found too great, so that while one size is not quite large enough, the next size is much too large. It is best, therefore, to be prepared with some hard-wood

FIG. 700.

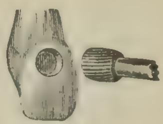


FIG. 701.

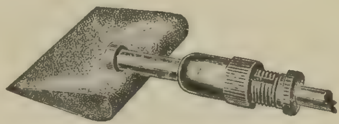


FIG. 702.

points, in shape like the wood polishing-points No. 3, and of closely graded sizes, to be used in the porte-polisher No. 307. A thin strip of bone or ebony or vulcanite should also be at hand having a series of holes that may be made with the barrel burs, each of which will make three different sizes, and the strip serves as a very useful gauge. Selecting then a hard-wood point (one made of copper or of tin-solder would be even better) a very little larger than the cavity, put in it some corundum polishing-paste and carefully grind the cavity larger, circular, and true down to the bottom. Of course, it is next to be thoroughly washed out with alcohol and dried with warm air. With a wheel bur No. 15, or oval No. 91, cut small grooves in the upper and lower walls, but not on the thin side-walls, which would thus be needlessly weakened. Select from the stock of broken or whole porcelain teeth, whether plain-plate, vulcanite, or gum teeth, one which will match the color of the natural tooth, and, with a corundum disc or other wheel, cut out a section somewhat larger than the cavity. But when a stock of cavity-stoppers is accessible, one of these will be preferable because made wholly of enamel, and therefore likely to take a better polish in the process of finishing.

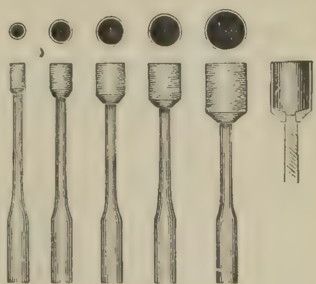


FIG. 703.

Fig. 703 represents a set of diamond trephines for cutting inlays from porcelain teeth. They are made of copper, charged with diamond, exactly like the diamond discs.

"It is worth while to spare no trouble or time or expense in matching as nearly as possible the exact shade of the tooth to be inlaid, because the success of the substitution will greatly depend upon the closeness of its resemblance to the natural tooth. In an emergency choose the lighter rather than the darker shade. When the suitable tooth has been found, and ground to an approximate diameter and thickness, cleanse thoroughly its enamel face with alcohol, and then with shellac melted but not burned, stick the face of the porcelain to the flat-faced end of a wood-point in the porte-polisher. After the porcelain has become quite cool, try it severely to be sure that it has stuck fast, because it will be annoying and cost valuable time if it shall be dislodged and need to be reset when nearly finished. For the purpose of illustration, a cavity-stopper is selected, and is shown mounted with shellac on a wood point. The porte-polisher is put in the engine hand-piece and rotated in contact with a corundum wheel or slab, Fig. 702. For more rapid grinding it may be rotated in contact with a revolving corundum wheel. The gauge previously mentioned will serve for frequent trials in the successive holes until the inlay fits the hole next larger than the cavity. Then the successive trials must be made in the cavity itself until, after grinding on a piece of Arkansas stone, the inlay exactly fits the cavity. In some instances it will be best to wet the inlay with a very fine polishing paste and grind it in the cavity. This is, however, somewhat hazardous, because of the liability of the inlay to get stuck fast in the cavity, and so endanger the cavity-walls. It is then best to grind on the corundum slab the bottom of the inlay, to allow it to settle in the cavity and take up the space previously occupied by the paste between it and the cavity-walls. A fitted inlay will resemble Fig. 704, and for greater security after it shall have been mounted, it will be necessary to cut with a sharp corundum disc notches on opposite sides of the inlay; and to insure the coaptation of these notches with the grooves in the cavity, and at the same time be sure that the inlay shall shade properly with the tooth, it will be best to detach the inlay from the wood before cutting the notches (Fig. 705). Both the cavity and inlay must be perfectly clean and dry before the inlay is lightly placed in the cavity, to determine which is its upper and which its under edge, so that the notches may be correspondingly cut with a clean, sharp, dry disc. Another reason for so cutting the notches is found in the fact that sometimes the lateral curve of the surface of the tooth will be so great that a groove on the lateral wall of the inlay would jeopardize the closeness of the joint on the surface at that point.

"It will, of course, be understood that the process described with reference to the porcelain cavity stopper is applicable to the prepara-

tion of any section from a porcelain tooth, and at this stage of the proceedings it is assumed that the clean, dry, notched porcelain inlay closely fits the clean, dry, grooved cavity. These are to be fastened to each other mainly by a locking-bit of cement or gutta-percha in each of the notches and grooves, in addition to a mere film of such plastic material between the cavity and inlay walls. This is the critical period of the operation, because of the extreme difficulty of so nicely proportioning and evenly distributing the cement or gutta-percha that the joining of inlay and tooth shall be complete in the actual contact of the marginal walls, excepting only the interstitial porosities, which are to be filled with the cement or gutta-percha.

"It is probable that the generality of operators will do best with the phosphate of zinc cement, but in any case, whatever the material of union is to be, the invariable prerequisites are—perfect dryness of both the cavity and the inlay, and some degree of warmth in each of them. These conditions may be best accomplished by a thorough washing of both with absolute alcohol, and the use of the hot-air syringe immediately preceding the mixing of the cement. This should


FIG. 704.


FIG. 705.


FIG. 706.

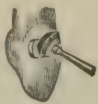


FIG. 707.


FIG. 708.

be mixed quickly and thin, and a mustard-seed bit of it taken on the blade of a small excavator and placed in the two grooves of the cavity, as also in the two grooves of the inlay; to be instantly followed by the rubbing of the walls of the inlay all over with the least possible cement on the tip of the finger. The inlay is then at once seated in the cavity and with a quick back-and forth grinding motion pressed firmly into place (taking care that the notches are in right relations to the cavity-grooves), and held under pressure fully five minutes. In cases wherein the inlay has been ground into the cavity, it may be better not to remove the inlay from the mandrel, but to thinly coat its walls with cement, and using the porte-polisher as a handle, turn the inlay into its seat (as a ground stopper into its bottle) with such firmness as to detach the inlay from its shellac attachment to the wood-point, and leave the inlay stuck fast in the tooth. A little white wax is then melted around the joint with a hot burnisher, and the patient dismissed for a subsequent sitting, at least five or six hours later; for it is of great importance that the cement be allowed to get hard before any strain is put upon the inlay. It is also essential to the proper seating of the inlay that no cement be allowed on the floor of the cavity or

the bottom of the inlay, because no amount of pressure will bring the walls into contact if there is a body of cement between those two flat surfaces; and continued pressure for a short time after the seating is necessary lest the elasticity of possibly occluded air lift the inlay from its seat before the cement or gutta percha shall have stiffened sufficiently to hold it in place.

"The rough grinding of the protruding portion of the inlay (Fig. 706) may be done with a stump or crown corundum wheel, until the margins are nearly flush with the tooth-surface, and then a beveled corundum point like No. 7 or No. 12 may be used, as shown in Fig. 707, to make the inlay conform closely to the contour of the tooth, and the final finish will best be given by an engine Arkansas stone beveled like 'R' or 'T,' and used with its further side in contact with the inlay or tooth, or both, as the case may be (Fig. 707). Such use of the side of a grinding or polishing wheel avoids the hollowing or wavy lines which commonly result from the peripheral contact of wheels or points with the convex surfaces of the tooth. Indeed, the preferable polishing instrument would be a device like the old engine

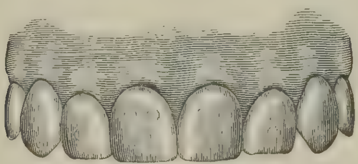


FIG. 709.

FIG. 710.

reciprocating porte-polisher, if it could be given power enough to be effective. A magnifying-glass will aid in making sure that the finish leaves the inlay border quite flush with the enamel at every point.

"Previous to attempting this method of repair, it is advisable that there should be some preliminary practice in setting inlays in teeth which have been extracted, or in pieces of ivory or bone; because there will thus be developed practical points which cannot be here described and yet are essential to the proper performance of the operation.

"The completed inlay, Fig. 708, when suitably adapted and finely finished, may well be considered as exemplifying the nearest approach to perfection in the accomplishment of dental repair that has as yet been achieved."

A method of applying hard or vulcanized rubber to pivot work has been suggested by Dr. J. Richardson, and is briefly described by Dr. J. E. Dexter, as follows: "An ordinary pivot crown is loosely fitted up with a wood peg, which also fits loosely the canal in the root. The

crown is ground from before backward so as to leave a space between the posterior portions of root and crown. Wax applied to the root and crown at once holds the crown and pivot in proper relative position and gives an impression of the root end. The whole is withdrawn, and so invested in plaster that the crown, peg, and wax may be removed, and the crown be capable of accurate replacement on the model. The hole in the root and root model are now properly drilled by the same drill to receive a gold wire pivot, the latter being long enough to project above the root into the crown, and being smaller than the holes in both root and crown, to allow of vulcanite enwrapping it within these spaces. Now the hole in the root model is packed with vulcanite gum, the gold pivot heated and pushed through the gum to its place, the hole in the crown also packed, and the crown forced to its position on the model over the projecting end of the gold pivot. More gum is packed in the palatal groove between root and crown, the whole flasked and vulcanized, and the finished crown forced to its place on the root, a few folds of gold foil being interposed to fill the joint tightly.

"Dr. Richardson also made vulcanite tubes for pivot sockets, to replace those of gold commonly used, by vulcanizing a layer of gum around a gold wire, which should afterward form the pivot. The wire, being wrapped in a single layer of tin foil, was readily drawn from the tube after vulcanizing, the tin being removed with muriatic acid. A proper length of the vulcanite tube was inserted in the root, either by force and a tight fit or by aid of plastic cements, and the pivot, vulcanized to a porcelain crown, was made to take up the extra space in the tube caused by the removal of the tin foil by bending, or by splitting and springing it open."

Also, Dr. H. C. Register's variation of this method, which "is to use an ordinary plain rubber tooth, and form its palatal contour with vulcanite. Through this a hole is drilled in line with that in the root, the latter being filled with hickory wood. The crown now being held in position, a drill is passed through the hole in the vulcanite into the wood in the root, and a gold screw pivot is passed through the crown into the wood root socket, holding the two firmly together. The details need no further description."

A method of pivoting a bicuspid is suggested by Dr. Bishop and described as follows by Dr. Dexter: "The root being a first bicuspid, both canals were opened, and a thin wire set loosely in each, the projecting ends being bent together like a staple over the root face. Gutta-percha was then packed upon the root face, around and under the wire staple. A plain rubber tooth was now ground to fit, and held in place while the gutta-percha was continued over its pins and shaped to contour.

"The whole was now removed together, invested, vulcanite gum substituted for the gutta-percha, and vulcanized. The tooth was set in place with plastics in the canals around the pins.

"This method appears to have much value for certain cases. Variations of it may be noted; for instance, using oxyphosphate, oxychlorid, or fossiline, in place of the gutta-percha, and leaving the tooth in place, for a temporary purpose, instead of removing and vulcanizing. Also, using heavier wires of platinum and iridium alloy for the pivots, and springing them apart, after vulcanizing, so as to obtain their spring pressure in maintaining the tooth in place."

Banded or Collar Crown.—Gold Collar Crowns consist of porcelain crowns with gold collars or bands hermetically inclosing the base of the crown and the neck and exposed portion of the natural root, in order to secure stability, and to prevent decay, and thus permanently preserve the natural root. Dr. W. H. Dwinelle, in the *American Journal of Dental Science*, April, 1855, was the first to suggest the banded or collar crown in connection with crystal gold, for restoring lost or fractured crowns. Fig. 711 represents the shape or mold into which crystal gold was packed, a plate tooth being first backed with gold, to which was soldered a band. The tooth was fastened to the root by a screw passing through a horizontal plate at the base of the backing into the dentine, and a somewhat larger screw was placed and secured in the pulp canal, with the free end projecting into the cap on the crown, and gold was built around this end and the cap filled.

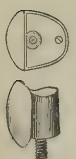


FIG. 711.

What may be more properly termed a "cap crown," or collar crown, was suggested by Dr. Wm. N. Morrison, in the *Missouri Dental Journal*, May, 1869. No screws or pivots were used in his method, but a cap of gold was made in the form of a tooth crown by being swaged on a model or die of a natural tooth, its sides encircling the root, and extending under the gum to the edge of the alveolar process. A bar was soldered across the inside of the cap to afford a support for the oxychlorid of zinc (the oxyphosphate will answer also). The root was then prepared for the reception of the cap, which was filled with the zinc preparation and pressed into place on the root. Dr. B. Beers, in 1873, suggested a method of forming a gold crown from a flat strip of gold by stamping it in the center on a block of lead with a punch. The gold was then annealed, and the two ends bent around the tooth (the stamped surface representing the labial surface of a front tooth), and these ends soldered together. The "bite" was then adjusted by means of a half-round file, so that the tooth articulated properly with its antagonists. A thick flat piece of gold was then bent to suit the form of tooth required and soldered

on the top of the gold crown, which was fastened to the root by inserting headed gold screws into the canal and then filling the cap with oxychlorid of zinc, when it was forced over the root to its proper place. Fig. 712 represents Dr. Beers' crowns and method of attachment to the roots of teeth.

Dr. E. S. Talbot improved upon the method of Dr. Beers by a band fitted to the root and extending to the alveolus, across the inside of

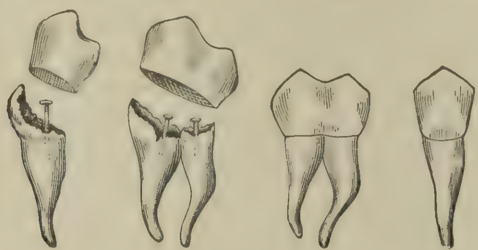


FIG. 712.

which a partition or floor of gold is soldered. In this floor holes are made opposite the pulp canals underneath. Wires are loosely inserted in these canals, and the space in the band beneath the floor is filled with gutta-percha or one of the zinc preparations, and the band or collars forced into position on the root, the wires projecting through the holes in the floor. After the gutta-percha or cement has become hard, the wires are drawn out, and headed screws are substituted,

FIG. 713.

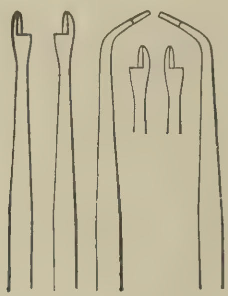


FIG. 714.

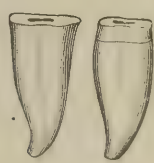


FIG. 715.

which fasten the band or crown to the root. The work is completed by filling the band with gold or by swaging a gold crown or cap, which is slipped over or within the edge of the band encircling the root, the cap being previously filled with cement.

Fig. 713 represents Dr. Talbot's method.

The collar of such crowns, as now made, consists of 22 to 23 carat

gold plate, or pure gold lined with platinum, or iridio-platinum alloy. The coronal portion of the natural root is prepared by first grinding the occluding surface with a properly adapted stump corundum or carborundum wheel (Fig. 716), and finishing with the corundum points. The approximal surfaces are removed by means of cutting discs and thin safe-sided separating files (Fig. 335, page 428), and the corners rounded. The exposed or cervical portion of the natural root is trimmed until it is brought to the shape represented by Fig. 715 *b*, in which the sides are parallel with the line of the root, and the cut surface extends as deep as the collar is to be placed. Fig. 714 illustrates the root-trimmers for shaping the cervical portion of the root. Where a large portion of the crown of the tooth is to be removed in preparing the root, a succession of holes may be drilled across such a portion, and the partitions removed by a fissure-bar or corundum disc. As much of the natural crowns of bicuspids and molars as possible should be preserved for the stability of the artificial crown when such is of all gold or a porcelain

FIG. 716.

facing is employed in connection with gold to form the crown. The preparation of the root canals is the same as before described. The root trimmers or reducers devised by Dr. R. W. Starr are intended for trimming the edges or reducing the diameters of roots over which collars are to be placed. The shoulder keeps the instrument on the root and limits the penetration of the spur, which, by its knife edge, scrapes the side of the root (Fig. 715 *a*), so that it may easily and quickly be given the shape of Fig. 715 *b*, or any similar form. They are made right and left (Fig. 714); the straight pair (Nos. 1 and 2) for use on the superior roots anterior to the molars, and the curved pair (Nos. 3 and 4) for use in all the other natural roots.

Dr. C. M. Richmond's method of making what are known as the "Richmond Crowns" is as follows: This crown consists of a close-fitting band or ferrule of coin-gold plate, to which a cap or surface, corresponding to the grinding surface of the class of tooth it is designed to crown, is soldered. The root is prepared by making the exposed surface flat by means of the file or corundum disc. A strip

of gold plate, about No. 27 American gauge, is then cut, of such a width as will extend from the alveolar process to a height sufficient to give the proper length of gold crown. To determine the proper width of the strip or ferrule, a pattern of tin or sheet lead, adapted to the tooth, may be used. The strip of gold plate is then bent with the pliers and filed to the proper form, and the overlapping ends soldered together, the ferrule being made slightly smaller than the root it is to encircle, so as to secure a tight fit. After the band or ferrule is completed, it is capped by a piece of plate large enough to cover the crown end, and the two soldered together, and properly finished by smoothing the sharp edges with a file and burnisher. The cap or crown is then adapted to the festooned margin of the gum and septa by filing the approximal edges concave. The margin of the gold crown, where it comes in contact with the neck of the root, is slightly beveled from the outside, in order to make a thin edge which will adapt itself to the surface of the neck under the pressure necessary to force the crown to its place on the root. The crown is then forced over the root, and the position of the artificial cusps yet to be made determined by the antagonism of the opposing teeth. Small, flattened buttons, made by melting scraps of plate and slightly flattening them by blows with a hammer, are soldered on the grinding surface of the gold crown, which is filled and invested during the soldering process with moistened sand, to which is added a little plaster. After thus attaching the cusps and contouring the grinding surface, the gold crown is ready to be adjusted to the root. A small hole is first drilled through the side or top of the crown, to allow the surplus cement, by which the crown is secured, to escape. The concavity of the crown is then filled with either the oxychlorid or oxyphosphate of zinc, mixed somewhat thinner than for a temporary filling, and the crown forced over the root and the patient directed to bite upon it, in order to secure the proper occlusion of the teeth. The crown is then firmly held in place until the cement has hardened, when the small hole through which the surplus has escaped can be filled with gold. Any slight defect in the articulation can be remedied by grinding with corundum points.

The method of Dr. H. W. F. Buttner is a combination of the ferrule, or band encircling the root, and a central pivot, and is described as follows by Dr. J. E. Dexter:—

"A special set of instruments is used in this process. Those for preparing the root are drills, reamers, and trephines (Fig. 717, *b c d*). The drill bores out the root canal. The reamer cuts the face of the root level, being guided by a central pin. The trephine turns the neck truly cylindrical for a certain distance up or down its sides, being also guided by a center pin. The root, thus prepared, is shown

in Fig. 718. The drill, reamer, and trephine are in various and exactly corresponding sizes.

"A steel wire is now placed in the root, projecting half an inch. An impression is now taken, the wire projecting through it, a cup with an opening over the root being used for that purpose. The wire is withdrawn carefully before removal of the impression from the mouth, but is afterward replaced. Over it, on the impression, is now slipped that one of a set of brass root models which corresponds to a drill and trephine used, and the model is then made, and holds the brass root model in its place, with the wire projecting. The latter is now removed, and plaster cut from around the root model to a depth sufficient to accommodate the cap which is to follow. This is of gold, struck out of the solid, on that one of the accompanying steel dies which accords with the trephine and root model used. It also has a central pin, to correspond with the drill which enlarged the root canal (Fig. 718). This cap is set on the root model, and a plain plate tooth,

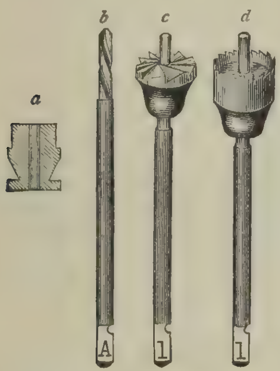


FIG. 717.

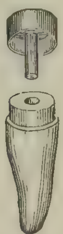


FIG. 718.

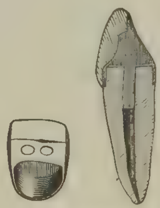


FIG. 719.

ground hollow on the inner surface, to cover the outer wall of the gold cap, is backed, and soldered in place on the cap—of course, after removal from the brass root model—the solder forming the palatal contour. The whole is now polished, placed on the root, and driven home with a mallet (Fig. 719).

"The perfectly accurate fitting of this operation is secured, beyond cavil, by the set of drills, reamers, trephines, dies, and root models with which it is performed. Probably—indeed, almost certainly—this is the *strongest* method of attachment of artificial crowns to natural roots which can be devised. Indeed, the only thing breakable about any given case of this method seems to be the porcelain crown or face. The end and interior of the root, also, are absolutely preserved from moisture for, at least, a very long time."

Another method of forming collar-crowns is described as follows by

Dr. C. S. W. Baldwin : * "Select a Logan crown slightly shorter than would be used for setting without a ferrule. Countersink and prepare the inside of a root as for a Bonwill or any ordinary crown. If the outside of the root at the margin of the gum presents an irregular surface, then with Dr. Starr's reducers (Fig. 714) shape it to such a size that the ferrule may be perfectly adapted to all parts. Take an impression, and produce in zinc or Babbitt's metal a die, to form which take a plaster model of the root-end, an eighth of an inch long, and shellac it to the point of a cone, which can be easily made by turning down a large spool, thus making the deep mold in sand into which the metal is poured. With this die strike the gold (22-carat, No. 30 gauge, is most commonly in use), laid upon soft lead. A few blows will produce a seamless and perfectly-fitting cover and ferrule. After trimming this to fit the festoon of the gum, drill in it from the lower side a hole for the pin of the crown, leaving the ragged edge produced by the drill. Then fill the countersunk portion in the porcelain crown with oxyphosphate of zinc, and with the gold ferrule or cap in place, adjust the crown as you would wish it when completed. When the oxyphosphate is hard, you will find the ragged edge on the upper side of the cover will materially aid in removing and keeping the cap where it belongs. Unite the cover to the platinum pin in the crown with a small amount of soft solder—tin and lead—using muriate of zinc as a flux, a few blasts from the blowpipe being all the heat required. Then fill the root with oxyphosphate and firmly press to place. These caps might be made up at leisure, providing a few variations for double and single rooted teeth. When a case is met that you cannot fit from your stock, choose a cap larger than the end of the root, and with a single clip of the shears cut to the center of the cap, and with pliers spring together, lapping the edges until the size required is obtained. Solder with gold solder by holding over the spirit-lamp, and proceed as before.


FIG. 720.


FIG. 721.


FIG. 722.

"Fig. 722 shows a root, cover, and Logan crown ready to be assembled for the soldering of the crown-pin to the cover ; Fig. 720 shows the cap cemented and soldered to the crown, and Fig. 721 the completely crowned root."

* *Dental Cosmos*, vol. xxviii.

Dr. H. C. Merriam describes a form of artificial crowns as follows:*—

"We need a crown that can be ground on its sides as well as against the root, with a straight hole through it, similar to that of the English tube teeth, excepting that the hole should come out at a greater distance from the cutting edge in the incisors and cuspids. After the crown is ground, to place the hole through, it may be formed as we desire with a copper drill and corundum, or with hard-rubber points dipped in corundum.

"There are now made, for use in machine-shops, wheels the corundum of which is united with a flux, and baked at a temperature of nearly three thousand degrees. These wheels hold a true edge, and when made small enough will be a great step in advance of what we have. I have had small points made in this way, with which I can grind out a crown to any of the forms illustrated in Fig. 723."

Fig. 724.

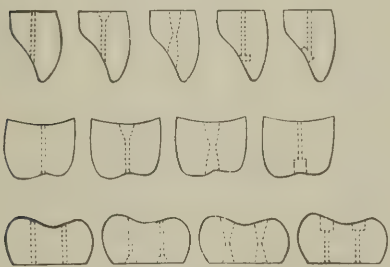


Fig. 723.

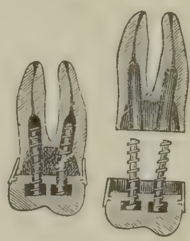


Fig. 725.

"I now show you some of the different varieties that can be made by grinding the crown just referred to (Fig. 724), the advantages of which have already been stated. With these crowns it is expected that dowels will be used, set in either cement or gutta-percha.

"We will now pass to forms which are to be secured by metal bands fitted either to the root or to the crown itself (the strongest, of course, being held at their periphery), and I will detail my method of applying the same, for it enables me to avoid the trouble and delay of investing or soldering. For these the crowns given in Fig. 723 may be used, as well as those shown in Fig. 724.

"The band is fitted to the root, and the crown ground into the band after proper occlusion with its antagonist has been obtained. If a

* *Dental Cosmos*, January, 1887.

molar, a fine groove is ground around it, and the band, after being corrugated on its inner surface with a small lining bur, is placed on a lead anvil and the tooth driven into it, thus partially securing the advantage of union by gomphosis. The common glass stopper is a good illustration of how little more than its fit would be required to retain it firmly in place. For this little I have drawn on the tube-teeth workers of England. A few small pieces of sulphur are then placed inside the band, and all held over a small flame until the sulphur melts and flows into the groove between the band and the crown. Zinc phosphate may be used before the crown is forced in, or some flux—borax, for instance, which melts at a low temperature, though this would probably require investing. We then have a crown which, if a molar, I do not fear to attach with gutta-percha without dowels; but others may not have this confidence, and dowels may either be put into the roots or set in the crown with cement, and afterward secured to their places in the root as usual (Fig. 725). It is evident that if

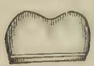


FIG. 726.

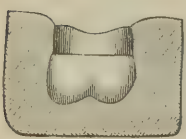


FIG. 727.

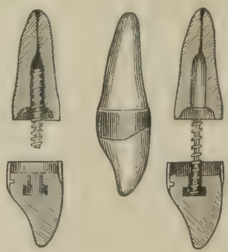


FIG. 728.

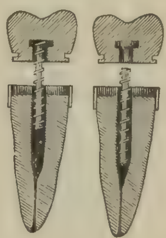


FIG. 729.

cement is strong enough to hold a dowel in the root it must be equally serviceable in securing the crown to the dowel. Some like the hardest way best. These may fit a fine platinum or pure gold wire into the groove around the crown (Fig. 726). Drive in as before; invest and solder (Fig. 727). A gold amalgam may be used, such as was employed by old plate-workers for banding a plate over the teeth. I have not tried this, but suggest it as of possible use, the dowels being put in as before. For the incisors the groove should not run around the anterior face of the crown, and I have not soldered these teeth in (Fig. 728). I have entire confidence in any form for the incisors and bicuspids where the root is well banded, the dowel put into the center, and the crown forced to place in gutta-percha (Fig. 729); while for the molars, if quite short, I do not care for the dowels. You will notice that this method does away with much of the showing of gold in molars, where such a result is desired (Fig. 730).

"When cohesive gold was first used we thought nothing could be more beautiful—the more conspicuous the better—but we gradually learned that the perfection of art was to conceal art. So it is with tooth-crowns, and we shall learn soon to omit great backings, etc., wherever possible; not only because they are conspicuous, but because a tooth backed up by any substance is no longer translucent.

"I will present one more form for molars, and although it shows more gold than any of the others, it is perhaps the strongest of all. The band is made full width down to occlusion, and any large, strong tooth is ground to fit the space to be filled in the arch. This is driven into the band so as to be even with its edge; cemented with

FIG. 730.

FIG. 731.

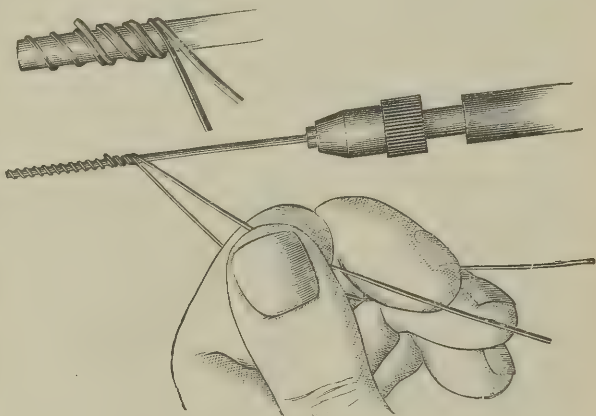


FIG. 732.

sulphur as before, and I think we have a crown that is made for all time (Fig. 731).

"*Setting.*—I first varnish the band inside with Canada balsam dissolved in ether; then fill the crown with gutta-percha and crowd it up against the root several times, to get an impression. When sure that I have the right amount of gutta-percha, I place the dowels in the root (if I am to use them); heat the crown; dip it into cajeput or any essential oil, and crowd it to place. The dowels I fit in the same way, wrapping them with gutta-percha and working up and down in the root until I get the impression, before the final forcing to place. I thus have the advantage of the dowel and hard center of gutta-percha to act as a plunger, and the soft, semi-dissolved gutta-percha comes back on the outside of the mass, forming, I think, the tightest root-filling known. I fill roots in this way with gutta-percha points when I do not use a dowel. The dowels used are made by wrapping a piece

of platinum and iridium wire with about one-third of a sheet of gold foil, which is melted on and the combination made true by being drawn once through a wire gauge. A piece of piano wire is then wound around it three or four times, to serve as a guide, and a fine platinum wire, previously drawn square, is caught and turned through the wire guide a few times, when the winding may either be finished by hand, or the end, after being started, may be placed in a lathe-chuck and wound up at once (Fig. 732). A piece of gold foil is then wrapped around the whole and the fine wire soldered on. A dowel made in this manner is not strained by having its thread cut, and the thread, being square and coarse or fine, as you wish, is strong and possesses plenty of grip.

"Should these forms prove as valuable as I hope, those at a distance from the cities, without gas, will find that the labor of crowning roots has been much lessened.

"When a root has broken off far under the gum it should be filled with gutta-percha and a temporary plate worn—if the loss be in the front of the mouth—until the root works down, when it may be crowned and the plate given up.

"In preparing roots after a large portion of the crown is broken away, I enlarge the pulp-chamber with a large, round bur, and, when even with the gum, follow with the revolving saw here shown (Fig. 733). With this saw I often cut off the remnants of a crown from the inside without wounding the gum or drawing a drop of blood, and am saved the unpleasantness of running a stump corundum wheel in the mouth. The outside of the root can sometimes be formed with the instrument here shown (Fig. 734)."


FIG. 733.


FIG. 734.

Fig. 735 represents porcelain cusp-crowns.

These porcelain cusps are designed for use with a gold band representing the body of the tooth. The band or collar is first fitted to the suitably prepared root, and the cusp-crown is then fitted in the collar. The collar is then filled with gutta-percha, cement, or amalgam, and the crown pressed into place. 1 shows in section a molar root, collar, and cusp-crown. 2 shows the same mounted.

In cases where it is desirable to show as little of the gold collar as possible, the forms indicated in 3 and 4 may be employed, the gold band being cut away on the buccal side, as shown in the cuts.

Dr. E. T. Starr, in the *Dental Cosmos*, describes an improved "die-

plate" and "hubs" for shaping metal cap-crowns, of his own suggestion :—

"In the construction of metal cap-crowns to cover natural teeth or teeth-roots there are many methods which result in good work, but in most cases the caps do not articulate as well as they might, for the reason that means for embossing the bicuspid and molar cusps are not at hand or available within the short time at the disposal of either the patient or the dentist. With the object of providing an easy and quick way of working under such circumstances, I have made a single

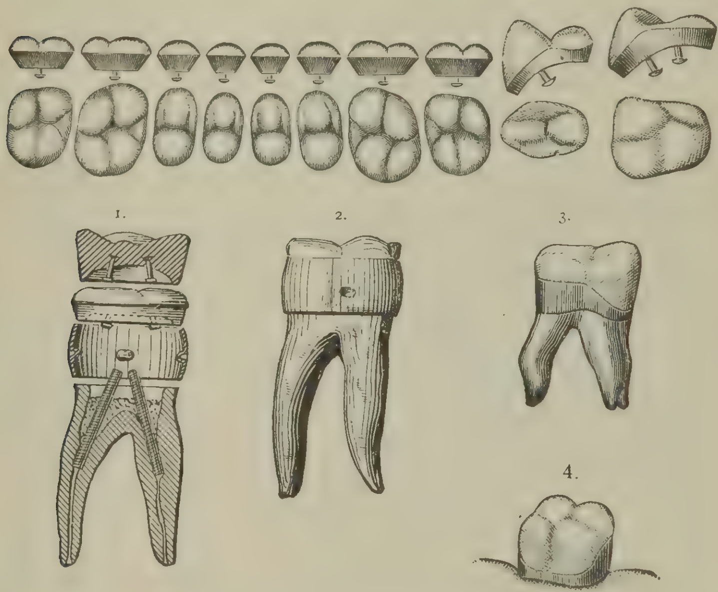


FIG. 735.

plate (Fig. 736) in which are four groups of intaglio dies representing with distinctive correctness the peculiar cusps of the upper and lower right and left bicuspids and molars. These are indicated by the Hillischer notation, so that each form may be easily identified in practice.

"The hubs A, B (Fig. 737) are of the sizes shown, and are made of an alloy composed of tin one part, lead four parts, melted together. The mold C should be warmed, the melted alloy poured in every hole, and the overflow wiped off just before the metal stiffens. This will make the butts of the hubs smooth and flat. After a minute or two the mold may be reversed, the hubs shaken out, and the casting process continued until a considerable number of hubs shall have been cast.

"In Fig. 738 a molar hub is shown in place on a piece of No. 32 gold plate, which lies over the 6. (upper right first molar) die. A

FIG. 736.

succession of blows on the hub, with a four-pound smooth-faced hammer, will drive the plate into the die, and at the same time spread the

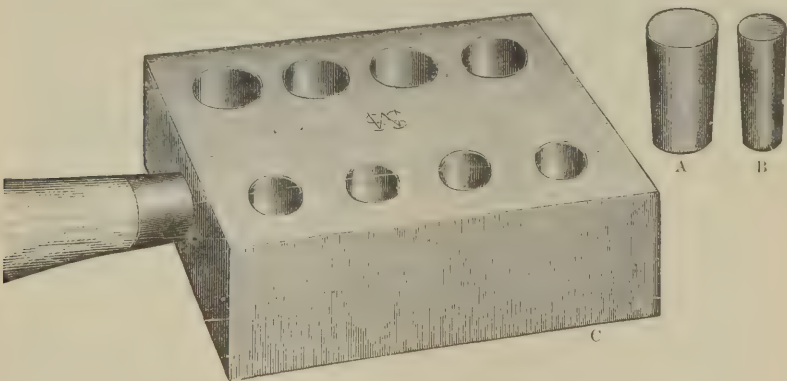


FIG. 737.

hub metal from the die center to its circumference in such a manner that the plate will be perfectly struck-up with the least possible risk of being cracked. The flattened hub is seen in Fig. 739, which also

shows at D the obverse of the struck-up hub, and at E the cameo of the struck-up plate, having every cusp and depression of 6. sharply defined.

"The counter-die plate (Fig. 736) is made of a very hard cast metal, which will admit of the striking up of many crown-plates by the means and methods described, if the crown-plates be not too thick and stiff. Of course they should be annealed before they are placed over the die. In careful hands, the die-plate should give clear cusp definitions after years of use.

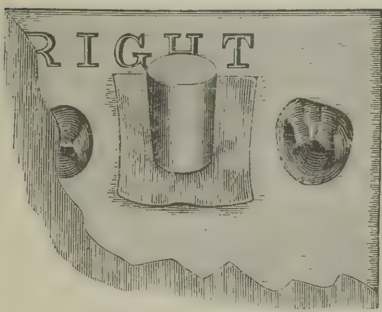


FIG. 738.

"For the reason that the counter-die plate is in some respects similar to a stereotype plate for printing, the struck impressions on two strips of thin plate will appear as in Fig. 740, wherein their regular order is noticeable as seen from the cameo surface of the struck plates. The peculiar action of the hub in forming first the center of the crown plate, and spreading from the center outward, as the hub is shortened under the hammer, until the die is overspread by the plate and hub, with the result shown in Fig. 739, is an essential feature of

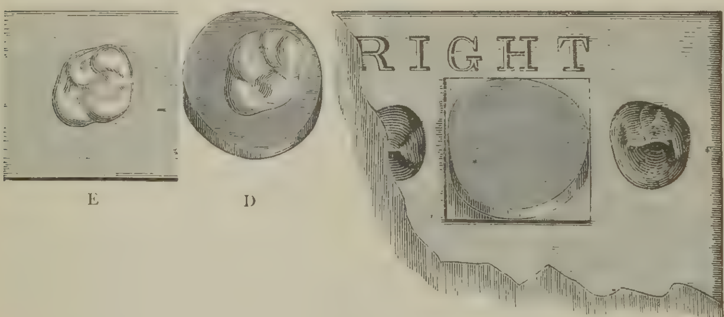


FIG. 739.

this process for obtaining easily and quickly the superior styles of coronal cameos shown. If a cusp or fissure should chance to crack in hubbing, a small piece of plate may be struck over it, or another crown plate be struck over the first and the two soldered together.

"The depressions in the struck plate can be partly or wholly filled

with scraps of plate or solder, and the surplus plate cut away from the cameo.

"The fact is noteworthy that, by means of the Knapp blowpipe, the coronal intaglio may even be filled with melted scraps cut from the identical plate out of which the cameo was struck. The better way, however, is to fill, say a twenty-carat cameo with eighteen-carat plate scraps. The fitting and soldering of the doubled or filled cameos to suitable collars is a simple matter, and need not be described.

"It only remains to add the statement that, by this counter die and hub process, gold, platinum, silver, or other metallic cap-crowns, having finely-formed and solid cusps for proper occlusion and re-

FIG. 740.

sistance to wear, can be made with little trouble and in a very short time."

All-Metal Crowns.—Entire crowns of either gold or aluminum are employed for capping badly decayed or fractured posterior teeth. These crowns may be made either in sections, composed of a collar or ferrule and grinding surface, or as seamless contour crowns by a stamping process. In constructing a crown in sections the collar of 23-carat gold may be first formed on a mandrel, and then placed in a die obtained from a model of a natural crown, and burnished to the sides, or stamped between a die and counter-die representing the crown of a natural tooth. After the collar, which may be seamless, or its ends soldered together, is contoured, the cap or grinding surface, of a size

suitable to adjust to the collar, is stamped with a die (Fig. 741) and adjusted and soldered to the collar. Having the collar part of the crown a little smaller or contracted than the cervical part of the prepared root which it is to cover, will permit of a nice adjustment, as the gold, especially in the case of a seamless crown, will expand when forced or slipped over the end of the natural root, and can be trimmed with curved scissors or shears, and closely adapted to the root and gum. Stamped seamless aluminum crowns are made in the same manner as the gold seamless crown, the construction of which is described by Dr. George Evans in his work as follows: "A contour crown can be made by placing a seamless cap on a sectional die or mandrel of the shape of the tooth, first swaging the grinding surface on the mandrel and then stamping downward on the straight sides of the crown with a cap fitted to the shank part of the mandrel." A sectional mold method is, however, more simple and practical, and is described by the same author for a molar crown, as follows: "A natural tooth, or one made of plaster, is used as a model. From this a sectional mold is made in Babbitt's metal, zinc, or fusible alloy. Into the mold a cap of gold 23 to 24 carats fine, 30 to 32 gauge, is adjusted, fitting tightly the orifice of the closed mold. The mold is placed in a vise, the cap expanded to the general form of the mold by hammering into it a mass of cotton, and then swaged more in detail to the form, and with a wood point or burnisher revolved by the dental engine burnished into every part of the mold. To facilitate the process, the mold should be frequently opened and the gold annealed." "Another method is to form a fusible-metal die of the tooth to be crowned, and, after having stamped the grinding surface of the crown, to reverse and swage the sides close to the die; the crown is then relieved of the core (die) by heating to the melting point of the fusible metal and pouring it out."

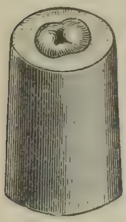


FIG. 741.

Figs. 742 and 743 represent solid gold cusps for crown and bridge-work.

Gold cap-crowns can be rendered more durable by filling in the under surface of occluding portion of the crown with gold solder.

Fig. 744 represents the Evans Gold Seamless Contour crowns for bicuspids and molars.

The Hollingsworth system for crown and bridge-work is described by its author as follows:—

"This system supplies, in the first place, a variety of forms for the various teeth, great enough to cover almost any case, and for the rare cases which cannot be suited direct it affords a ready means of making the exact form required. There are in the set 204 forms of

cusps and 36 of facings for bicuspids and molars, and 40 forms for incisors and cuspids. These last give both the labial and lingual faces. All the forms are exact fac-similes from nature, selected with

FIG. 742.

FIG. 743.

great care to cover the widest range possible. They are made of metal, and are used as patterns from which to make dies or molds, as may be required, for the swaging of gold cusps, or crowns. There is

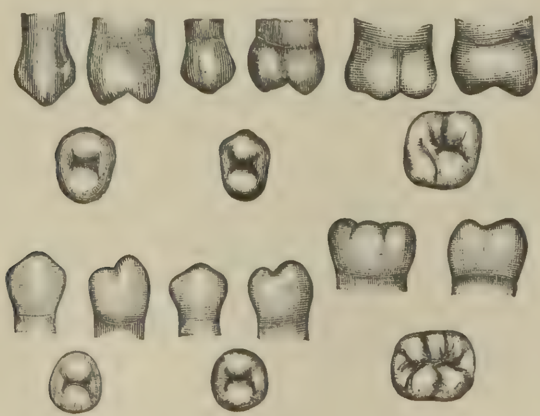


FIG. 744.

therefore, no wear upon them, and they retain their shapes and sizes unaltered.

"The outfit for working these forms consists of a molding-plate, three rubber rings, a sheet of asbestos 10 × 7 inches, a carbon stick for use

in casting, and a box of Hollingsworth's annealed copper strips for measuring roots.

"This system permits cusps to be made either hollow or solid. Scrap gold can be used for casting solid cusps, and porcelain facings can be quickly inserted in crowns without investing; but perhaps its most

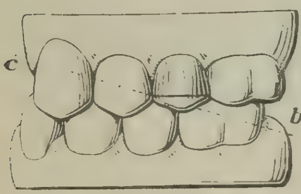


Fig. 745.

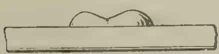


Fig. 746.

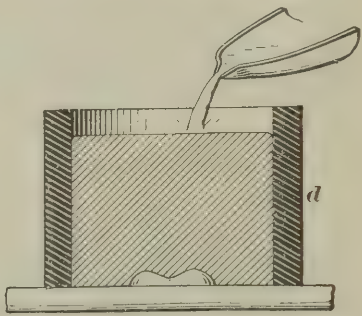


Fig. 747.

important advantage is the exactness with which the fit and articulation of bridges are obtained and maintained."

To Make a Gold Crown (*Bicuspid or Molar*).—Make a band to fit the root in the ordinary way. Place the band in the mouth (see Fig.

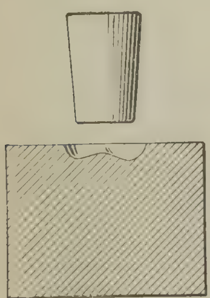


Fig. 748.

Fig. 749.

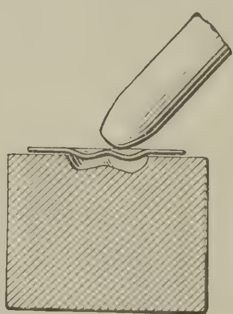


Fig. 750.

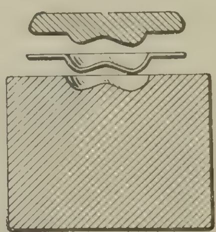


Fig. 751.

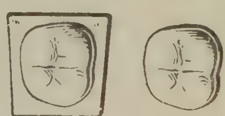


Fig. 752.

745), and cut off on a line where the adjoining teeth begin to turn to form the cusp (see *c*, Fig. 745). Place a small piece of wax inside the band to assist in holding the cusp-button, which should be selected to fit the circumference of the band, to articulate properly, and to correspond in shape with the other teeth (see *b*, Fig. 745). Remove the

button, and place it on the molding-plate with the grinding-surface up (see Fig. 746). Place the small rubber ring *d* around it, pour in a sufficient quantity of Melotte's metal to nearly fill the ring (Fig. 747). As soon as the metal sets, chill the surface by dipping in water for a moment, and then remove the rubber ring. When the heat begins to return to the surface, a quick rap of the die on the bench will cause the cusp-button to drop out and leave the mold ready to form the gold cusp. Now take a piece of lead, such as our lead hubs, and with a hammer drive into the Melotte-metal die (Fig. 748) to form the counter-die (Fig. 749, *d*).

Anneal the gold plate, and start the swaging process by coaxing the plate into the die by hand-pressure (Fig. 750), using a piece of wood, which makes a depression for the lead counter-die to rest in. Then place the counter-die on the gold plate (Fig. 751), and drive to a fit. Cut the surplus metal from the hollow cusp with shears (Fig. 752), filing up the edges when necessary, and rub down the under surface on a smooth file until it fits the band made for it (Fig. 752). Wire the cusp and crown together, place flux and solder in the cap, and hold over a lamp until soldered (Fig. 753). Then finish in the usual way.

If the forms of cusp-buttons do not afford one which articulates perfectly, the difficulty is easily remedied by taking the button which most nearly answers, and building up the cusps with Melotte's moldine (Fig. 754). If a band is accidentally cut too short, it can still be utilized. Place moldine upon the molding-plate, put the cusp-button upon it, press down and adjust to make up the deficiency of the band, cutting away the surplus moldine.

FIG. 753.

FIG. 754.

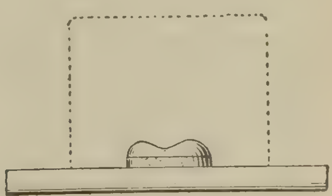


FIG. 755.

This will of course throw the soldering line a little further upon the crown (Fig. 755).

Scrap gold can be utilized for making a solid gold cusp by casting in asbestos by the following method :—

After selecting the desired cusp-button, instead of making a mold in Melotte's metal, as before described, take a piece of asbestos board

about one inch square and one-fourth inch thick, moisten it, and with a hammer drive the cusp-button into it, flush with the surface of the button. (See Fig. 757.) Remove the button, and dry the asbestos in a flame (Fig. 756). When perfectly dry, place a sufficient quantity of gold scraps in the die made in the asbestos, and direct the blow-pipe flame upon it until melted, inclining the carbon stick, as shown, against the die for the double purpose of confining the heat and warming up the carbon stick. When the gold is fused into a button, press it into the die with the carbon stick (Fig. 758). *Avoid the use of flux when working with asbestos.*

FIG. 756.

FIG. 757.

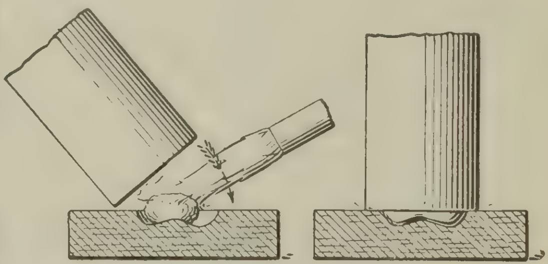


FIG. 758.

To build up a cusp to make a perfect articulation, in this method, sealing-wax must be used instead of moldine, as in the method of swaging the cusp. Warm the button before applying the wax, and with a warm instrument shape the cusp as desired.

To Make Gold Crowns (*Centrals, Laterals, and Cuspids*).—Select from the forty different forms in the set that which is most suitable to

FIG. 759.

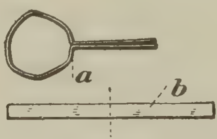


FIG. 760.

FIG. 761.

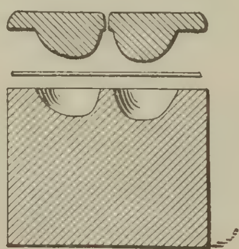


FIG. 762.

the case in hand (Fig. 759). (The forms are in pairs, showing labial and lingual surfaces.) Take the measurement of the root to be crowned with one of the annealed copper strips, binding the strip around the tooth with pliers (Fig. 760 *a*). Take this measurement

and cut it through the center (Fig. 760 *b*), then bend the respective halves over the lingual and labial forms selected, at the necks, with the cut ends of the strips resting on the flat of the plate (Fig. 761). If the measurement is larger than the form selected, build the latter up with moldine until the space between the form and strip is filled (Fig. 761 *b*). Avoid getting moldine on the approximal surface. Remove the strips, dry out the moldine by passing through a flame a few times, then place the form on the molding-plate with a rubber ring around it. Pour Melotte's metal into the ring as in forming the molar or bicuspid cusp, which makes a die of the two sections, lingual and labial. Make a lead counter-die and proceed as directed in the making of a molar cusp, swaging both sections (Fig. 762). Trim off the surplus plate (Fig. 763), and square the opposing edges of the two sections by rubbing them over a dead smooth file. Bind the two sections together with wire with sufficient solder and flux inside (Fig. 764, and Fig. 765), and proceed as in soldering an ordinary band. With a small mechanical saw cut off the upper portion where the tooth begins to slope back (about the dotted lines in Fig. 765). This leaves the crown as shown in Fig. 766, approximal and labial views. Drive on the root. If too small, place on the horn of an anvil and enlarge by hammering; if too large, band the root in the same manner as for a Richmond crown, grinding the tooth to fit.

FIG. 763.

FIG 764.

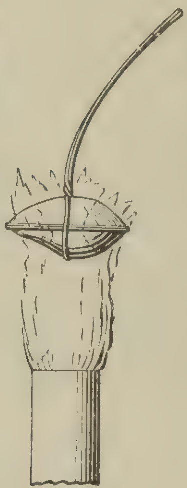


FIG. 765.

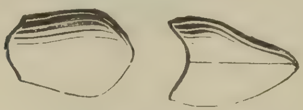


FIG. 766.

To Insert a Porcelain Facing.—Make the gold crown as described. Select a porcelain facing suitable for the case (Fig. 767). Place the crown on the root in the mouth, and with an excavator mark on the face where the porcelain is to appear. Remove the crown and saw out, so that the facing will fit loosely. With a knife bevel the inner edge or seat for the facing (Fig. 768). Grind the facing to fit (Fig. 769). Back up the facing with No. 34 or 36 gauge pure gold, punching holes in the backing for pins, annealing as required to readily conform it to the tooth (Fig. 770 and Fig. 771). With a sharp knife

cut a barb on each side of the pins in the facing, and press the barbs against the backing (Fig. 772), which keeps the backing in place. Burnish down the edges well, being careful not to let the backing overlap the facing.

Place the facing in the space prepared for it in the crown (Fig. 773), and bind the two together (not too tight) with wire, wrapping the wire directly over the facing with asbestos to prevent discoloration of the porcelain. Flux and solder by holding over a lamp as in the case of a band (Fig. 774). Then finish in the usual way.

If it is desired to use a platinum pin for anchorage, as, for instance, a Logan pin, bend the pins in the facing sufficiently to clamp the anchorage pin, and insert the pin through the gold crown (Fig. 775),

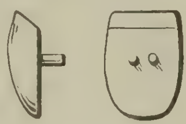


FIG. 767.

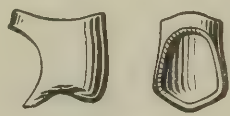


FIG. 768.

FIG. 769.

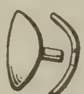


FIG. 770.

FIG. 771.

FIG. 772.

FIG. 773.

FIG. 774.

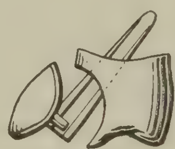


FIG. 775.

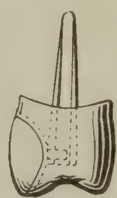


FIG. 776.

finishing as before described. Fig. 776 shows a finished crown so made.

To Make the Grinding Surface of a Bridge in One Continuous Piece.—After having crowned the teeth for the attachment of the bridge, take a bite in modeling compound, remove the compound, place the crowns in their impressions, make a cast of sand and plaster, and place on an articulator; now put moldine between the abutments instead of wax, and get the articulation with cusp-buttons the same as you would for plate teeth (Fig. 777). Then to remove the buttons without destroying the articulation, make a cup by pouring Melotte's metal, as cool as it will flow, on the face of the cusp-buttons. Heat the pouring lip of the ladle and use it to smooth out the half-congealed metal,

much as you would a soldering iron (Fig. 778). Then place a thin coating of moldine upon the molding-plate. Remove the cup from the articulator with the cusp-buttons in place (Fig. 778). Transfer the cusps by inverting the molding-plate (Fig. 779), and turn the cusp-buttons out upon the moldine on the plate with the grinding-surface up (Fig. 780), and they will occupy the same relative positions as when on the articulator.

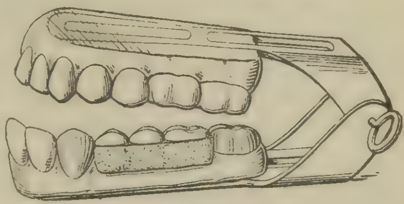


FIG. 777.

Now place the large rubber ring around the buttons on the plate, and proceed to make a die with Melotte's metal, as before described (Fig. 781). When cool, remove the buttons and coat the face of the die with whiting. Invert the die and raise the rubber ring sufficiently

FIG. 778.

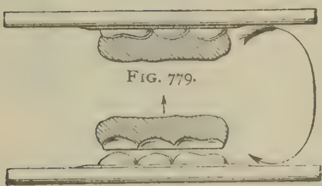


FIG. 779.

FIG. 780.

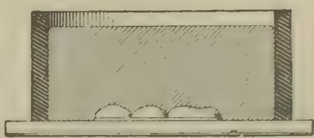


FIG. 781.

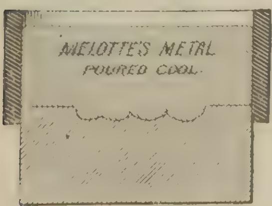


FIG. 782.

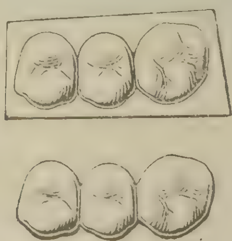


FIG. 783.

FIG. 784.

high on it, and make a counter-die with the same metal by pouring as cool as possible (Fig. 782). This gives the male and female dies with which to swage the continuous grinding-surfaces. Then proceed to swage the gold plate in one piece (Fig. 783), annealing as often as

necessary. Trim off the surplus plate (Fig. 783), and place in position on the articulator. Cut the cusps out on the buccal face to avoid showing the gold (Fig. 784), grind the porcelain facings to fit the cusps, and back with gold, No. 34 or 36, letting the gold come to the cutting-edge, the same as in a single crown as before described.

If there is a space between the cutting-edge and the porcelain, place a little wax in the joint to keep out the plaster investment, invest, remove the wax from between the joints, flux, and solder.

If it is desired to make an all-gold bridge, select the proper facings from the set, make a die of Melotte's metal, and swage up, the same

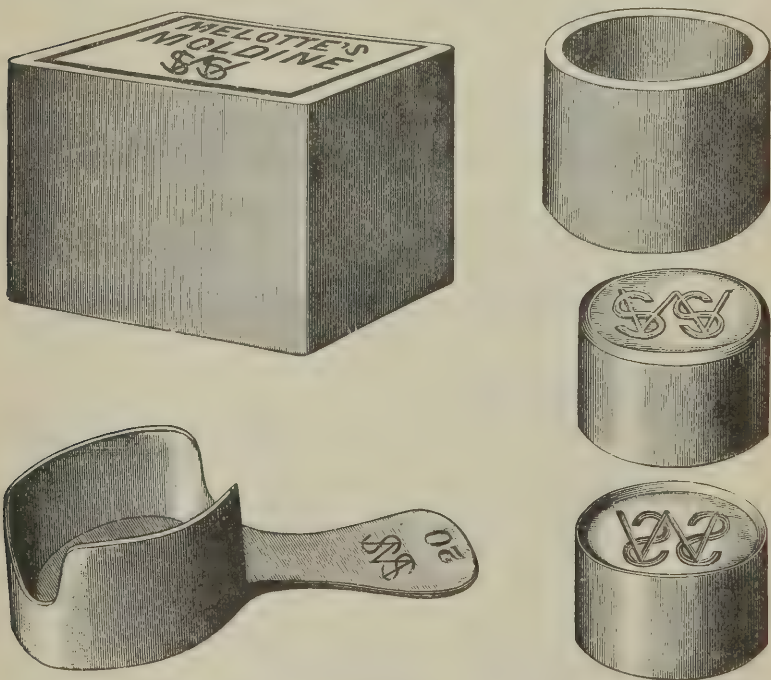


FIG. 785.

as in the continuous bridge before described, and mount gold facings in place of porcelain.

NOTE.—In case it is desired to mount a gold tooth on a vulcanite plate, select the proper form from the set, and make the crown as described. Solder pins on the back, and vulcanize to the plate in the usual way.

These strips will be found more desirable and practical than the ordinary binding-wire for taking measurements of roots, especially of badly decayed teeth. To use them, the strip is passed around the

tooth, and the joint pinched firmly with a pair of pliers. Where the decay runs under the gum, tack the ends of the strip together with soft solder, and with an excavator carry it well up under the gum.

Fig. 785 represents Dr. Melotte's moldine, impression cup, rubber ring, and fusible metal for crown dies and counter-dies. Moldine (molding sand and glycerin) is an impression material into which the metal can be poured as soon as the impression of the crown of a tooth is obtained.

Bridge Work.—Artificial Crowns Attached to Natural Teeth without Plates or Clasps.—These operations are generally known as "bridge-work," which is simply an extension of artificial crowns over the spaces made by the loss of natural teeth. The credit of first inserting artificial crowns to adjoining natural teeth, by fillings of cohesive gold foil, is due to Dr. B. J. Bing, who describes his method as follows:—

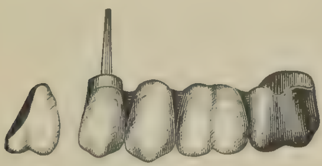


FIG. 786.

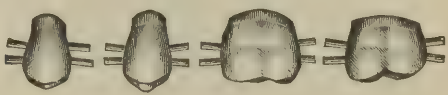


FIG. 787.

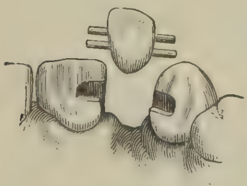


FIG. 788.

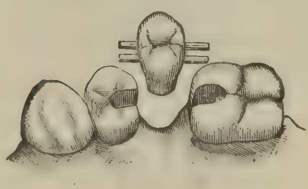


FIG. 789.

"In the case of inserting a central incisor, a cavity must be made in the palatine depression of the adjoining central, and also the lateral, and one in the approximal surface of either of these teeth, about the place where we usually find decay on these surfaces. An impression is then taken which will show these cavities, and a gum or plain plate tooth carefully fitted and backed with gold, observing the precaution of allowing a small point of the backing to extend into the approximal cavity. Two little griffes (bars) are then soldered to the base of the backing, the ends of which are carefully plugged into the palatine cavities with gold foil, in such a manner as will tend to draw these teeth very slightly together."

Figs. 787, 788, 789, 790, and 791 represent Dr. Bing's bridge-teeth.

Fig. 789 represents porcelain crowns having two strong pins of

platinum baked in each side, the pairs of pins being so placed that the tooth when fixed in position is held firmly in proper relations to the adjacent teeth. Fig. 788 shows the supporting teeth prepared to receive a lateral incisor. Fig. 790 is a face view of the same in position. Figs. 789 and 791 show the same in the case of a bicuspid crown.

These crowns may be soldered to each other, or to collars and to cap-crowns, in the construction of every form of bridge denture.

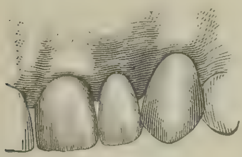


FIG. 790.

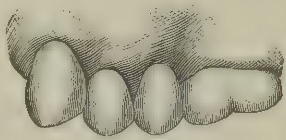


FIG. 791.

Dr. W. F. Litch has modified Dr. Bing's method, an abridged description of which, by Dr. Dexter, is as follows :—

"Supposing a left upper lateral to be inserted: Take an accurate impression of the parts (canine and central, and gum between), and make metallic dies from the model. Swage gold or platinum plates to very exactly fit the palato-approximal surfaces of the canine and central. Fit into the interspace a plain plate lateral incisor, slightly wider than the space to be filled, beveling and grinding the sides

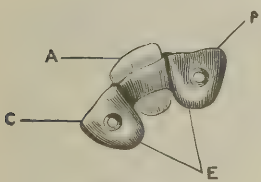


FIG. 792.

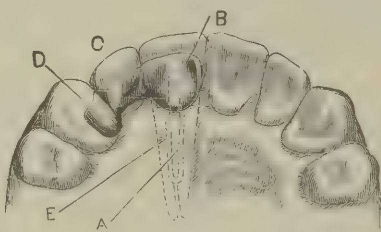


FIG. 793.

posteriorly, so that the tooth cannot be forced backward between its neighbors; the neck fitting accurately, but lightly, upon the gum. Back the tooth with gold. Place the prepared tooth and the struck plates upon a perfect model of the parts, and adjust the tooth backing accurately to the plates on each side. Cement together with shellac or other resinous cement; remove and complete the final adjustment in the mouth. Invest, and solder the tooth and plates together in their exact relative positions, observing to accumulate a large portion of solder over the joints (Fig. 792). The apparatus, if now placed in the mouth, will be found self-supporting against any force except the

perpendicular; for it cannot be forced backward into the mouth, owing to the extra width of the lateral; nor forward out of the mouth, owing to the wings or plates extending over the backs of the neighboring teeth; nor upward toward the gum, owing both to the porcelain tooth resting thereon, and to the converging planes of the plates or wings and the postero-approximal surfaces of the artificial tooth.

"The methods of final attachment are two, depending upon the case: 1. If one of the neighboring teeth is devitalized, attaching a pivot to the plate on that tooth and inserting it with gutta-percha, the plates themselves being covered with a film of the same substance on their dental aspects (Fig. 793). If the teeth are both alive, a modification of Bing's plan of filling, performed as follows:—

"The denture being constructed as before described, and polished, drill a cavity in the center of the palatal face of each tooth covered by the plates, slightly larger in diameter than the head of the pin in an ordinary rubber tooth, no deeper than the enamel, and undercut (Fig. 794 B). To each of these openings fit a platinum one-headed rivet, the head being very thin and perfectly flat on each side. Split the

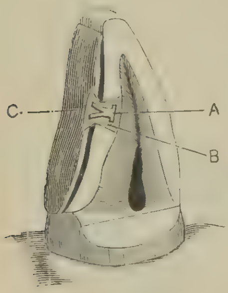


FIG. 794.

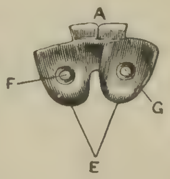


FIG. 795.

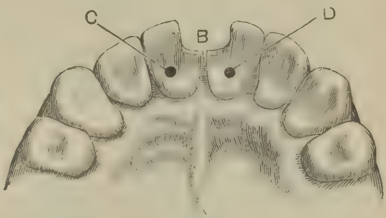


FIG. 796.

shanks of the rivets nearly to the head (Fig. 794 A). Make openings in the plates to exactly correspond with those in the teeth, and countersink them deeply on their palatal aspect. Place the gutta-percha on the dental surfaces of the plates, as described, and press the denture to its place in the mouth. When the cement is cooled and hard, remove that portion pressed into the holes in the plates and teeth, pass the rivet heads through the holes in the plates to their seats in the tooth cavities, and fill them in position with gold. When the fillings have reached the level of the tooth surfaces, spring open the split rivet shanks and continue packing gold around and between the separated parts and into the countersinks in the plates until flush with the plate surfaces. Cut off the surplus pivot shanks and finish (Fig. 794)."

Dr. Litch's method can also be adapted to the restoration of fractured angles of incisor teeth, as shown in Figs. 795 and 796, and which need no further description.

Fig. 797 represents a case of two bicuspid crowns secured to one root and two adjoining teeth.

The late Dr. M. W. Webb also modified the methods of Dr. Bing by forming an undercut groove in the porcelain crown in each side and along the cutting-edge, and filling gold foil solidly in the groove and slightly over the cutting-edge, to make the porcelain crown more secure than the platinum pins hold it, and to protect the edge from the occlusion of the lower teeth; also to build the crown into the approximal surfaces only.

Dr. Webb also described a method by which a crown without plate or clasps and where no root remains can be inserted: "After suitably forming the cavities in the proximate wall of each tooth next the space left by the loss of the one that had been extracted, a plain porcelain crown was fitted to the place and backed with gold plate. A portion

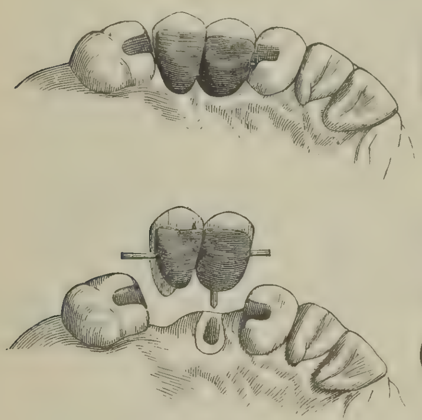


FIG. 797.

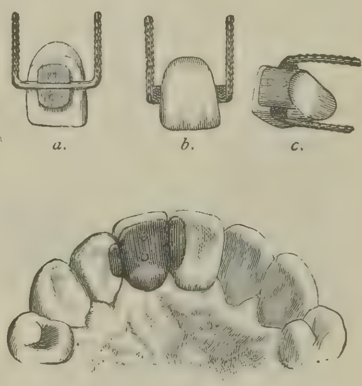


FIG. 798.

of the backing extended about one and a half lines from each side of the crown for insertion in the cavities prepared in the adjoining teeth, and to these parts a gold wire was soldered to fit into the pulp-chambers of the adjoining teeth. A small gold plate was then formed to fit upon the gum, covering as much space as was taken up by the neck of the natural tooth. When the backing was riveted to the pins in the crown and this placed in position, and while the whole rested on the small plate upon the gum, the backing and plate were so secured by wax that they could be removed intact and soldered. Each extended side of the backing and the surface of the wire was barbed, so that the gold foil would the better secure the crown when filled into every part. The crown with the gold attachments being ready for insertion, oxychlorid of zinc (or oxyphosphate) was placed in the pulp-

chambers of the adjoining teeth and the crown at once pressed to place. When the cement had hardened, a portion of it was cut away, so as to make proper anchorage for light, cohesive gold foil, which was impacted in small pieces around part of the wire and that portion of the plate extending into the cavities, and the crown was then secured."

To avoid any danger of the porcelain crown being broken from the platinum pins, Dr. Webb suggested that a groove be cut in each side, and along the cutting-edge of this crown (Fig. 798 *d*), so that gold foil may be impacted into it by means of a fine-edged corundum disc, after a heavy backing of gold plate and the wire have been fixed in place and soldered (Fig. 799 *a*). Into this groove the wire to connect the artificial crown with the natural teeth is to be placed (Fig. 798 *a*). When the operation of contouring the palatal surface of the crown

FIG. 799.

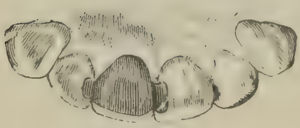


FIG. 800.

FIG. 801.

with gold foil is completed, the case presents the appearance shown by Fig. 800.

Dr. Webb also made use of a stout wire (No. 13), with a screw thread cut upon one end, for insertion into a devitalized tooth, and bent to receive the porcelain crown which was soldered to its free end, the wire being secured in place in the natural tooth by filling around it with gold foil (Fig. 801).

Figs. 802, 803, and 804 show an extensive operation performed by Dr. M. W. Webb, in which he made use of gold wire (No. 13) for bridging a lateral incisor, the natural tooth having been lost, and also the crown of the left cuspid, and disintegration having taken place in many of the teeth, and the front teeth abraded to the dentine. Fig. 802 shows the cases as prepared for filling, with the artificial crown attached to the gold wire in position, and gold screws inserted in the pulp-chambers of the cuspid and bicuspid teeth.

Fig. 803 shows the labial contour of each crown after the lost portions were restored with gold foil. Fig. 804 shows the finished case.

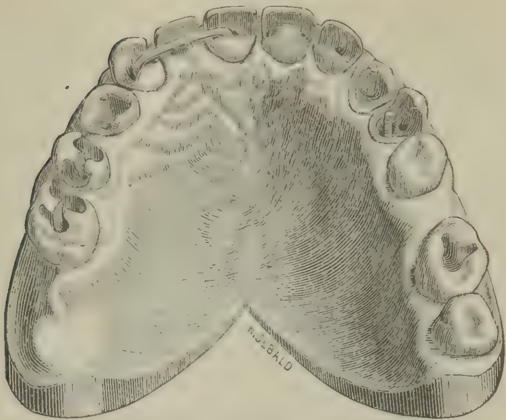


FIG. 802.

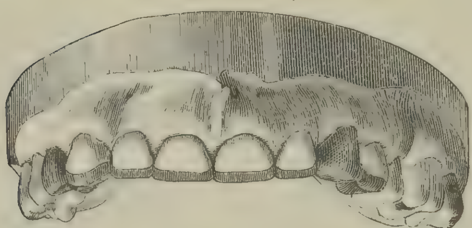


FIG. 803.

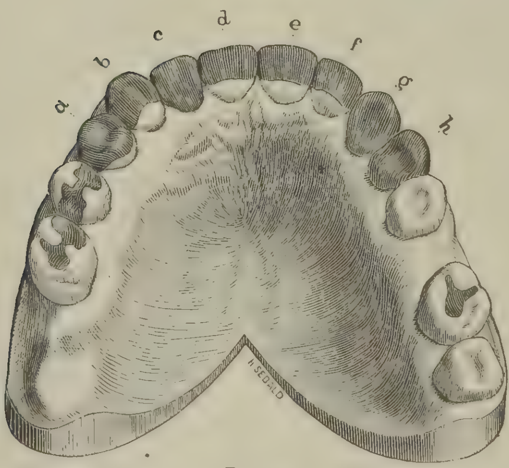


FIG. 804.

Finished case—*a*, *b*, *d*, *f*, *g*, and *h*, pulpless teeth; *g*, whole crown restored with gold; *a*, *f*, and *h*, almost entire gold crowns; the teeth *b* and *d* support the gold crown faced with porcelain, *c*, and fully one-fourth of the crown of each of these is restored with gold, as is also that of *e*, the pulp of which is living.

What is known as the "mandrel system" of bridge-denture is described as follows: *—

In all of the various systems of crown and bridge-work which have been brought to the attention of the dental profession, one very important point seems to have been overlooked, viz., the comparative conformation of the necks of different classes. The general forms of the crowns of teeth have long been well-known, but so far as we are informed no systematic classification of the shapes of the necks has heretofore been made. It would appear that such a classification ought to form the basis of any system of crown and bridge-work claiming a scientific foundation. To lay the groundwork of the system here described a large number of human teeth of the various classes were secured, their crowns cut off, and the shapes of the stumps accurately determined; thereby developing the fact that, no matter how great differences may exist in the apparent shapes of the crowns of individual teeth of a given class, there is a remarkable uniformity in the configuration of their necks. That is, the necks of upper cuspids, for instance, were found to have a fixed type, from which the variations were very slight as to shape, though there appeared to be no exact standard of size. So of the other classes, with the single exception of the superior molars, in which two distinct forms were found, the first being those in which the buccal roots were wider than the palatal; the second, those in which the reverse condition was found, the single palatal root being wider at its junction with the crown than the two buccal roots. The occurrence of roots of the second class being rather exceptional, the first class was accepted as the type.

The configuration of the necks of all the teeth having been determined, a set of mandrels for shaping collars to fit them was devised. The set (Fig. 805) consists of seven mandrels, six of which are double-end. Their shapes are modeled upon the general typal forms of the necks of the teeth which they represent, and they are made tapering to provide for all required variations in size. The illustrations are about two-thirds actual size, the longest instruments being nine inches in length. The cross-sections show the shapes and proportionate sizes at the greatest and least diameters. The long taper permits the most minutely accurate adjustment of the collar.

No. 1 is a double-end mandrel, for superior molars, right and left; No. 2 is a single mandrel, for superior bicuspids, right and left; No. 3 is a double-end, for superior cuspids, right and left; No. 4, double-end, for superior centrals, right and left; No. 5, double-end, for inferior molars, right and left; No. 6, double-end, for the inferior

* *Dental Cosmos*, Aug., 1886.

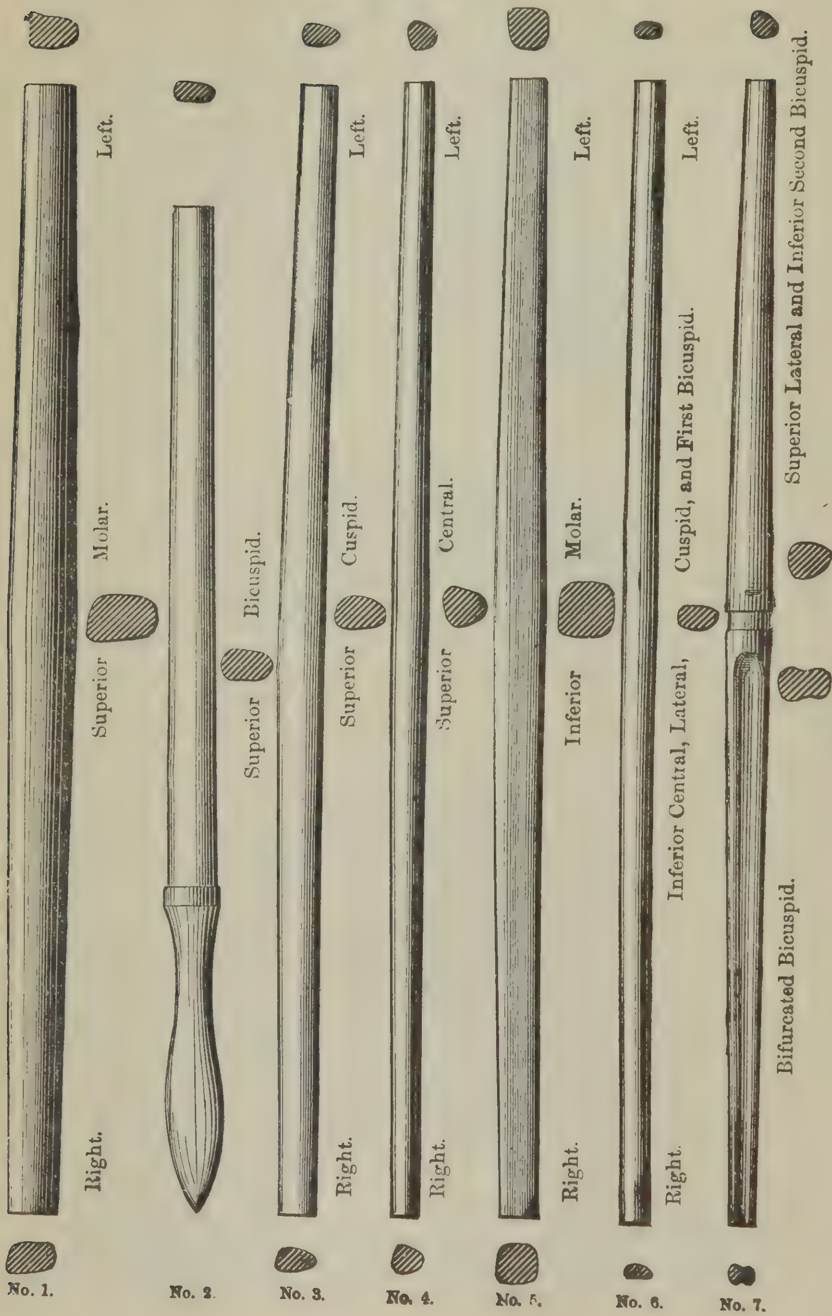


FIG. 805.—Mandrels for Shaping Seamless Tooth-Root Collars.

centrals, laterals, cuspids, and first bicuspids, right and left; No. 7, double-end, one end for the superior lateral incisors, the other for those bicuspids in which a bifurcation of the roots, or a tendency in that direction, extends across the neck to the crown, in the form of a depression on one or both approximal surfaces. The foregoing scheme comprehends all the teeth of the permanent set except the second inferior bicuspids. The necks of these approximate those of the superior central incisors so closely in shape that it was deemed inexpedient to make a separate mandrel, as the No. 4 mandrel will serve for both.

The collars or bands are made seamless, of No. 30 (American gauge) gold plate, 22 carats fine. Fifteen sizes, each of three widths ($\frac{1}{10}$, $\frac{2}{10}$, and $\frac{3}{10}$ inch) are made (Fig. 806), which it is believed will cover all requirements. These collars, although devised as a part of the system, can be used in all methods of crown and bridge-work which require bands, and possess many advantages over any others. They are really labor-saving devices, as their use saves the time and trouble of making, and there is no danger of their coming unsoldered when the pins or the backing of the crown is being soldered; and there are no hard spots to give trouble in burnishing, as, for instance, close to the root, after the collar has been shaped and placed in position, the whole surface being uniformly soft.

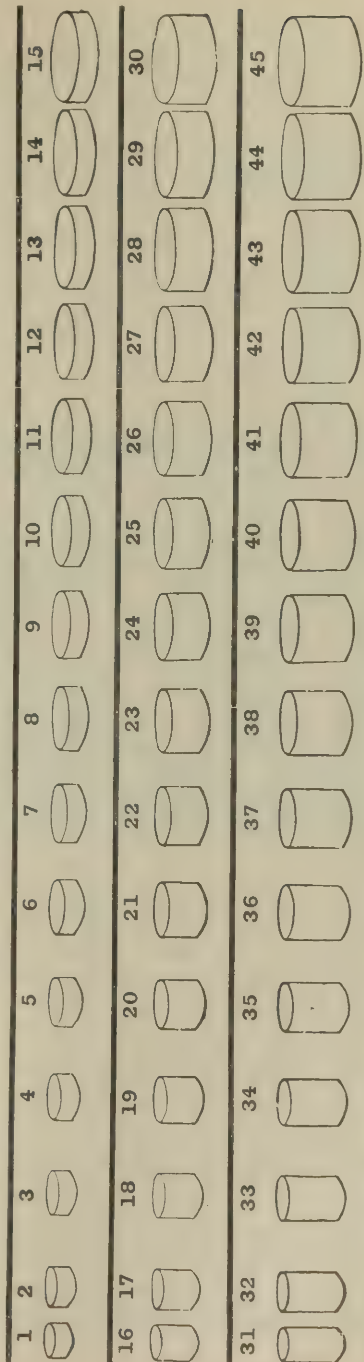


FIG. 806.—Seamless Gold Collars for Crown and Bridge-Work. (*Copyright, 1886, by the S. S. White Dental Manufacturing Co.*)

The seamless collars are also especially adapted to removal or detachable bridge-work. They are so constructed that Nos. 1, 16, and 31 exactly fit into or telescope with Nos. 2, 17, and 32, and so on through the entire set, each collar fits into the series next higher; so that a root may be banded with one size and the size next larger used to form the tube for the telescoping crown. Their advantages for the construction of cap crowns are obvious.

The other appliances specially devised for this system are, a reducing-plate or contractor, a pair of collar pliers, and a hammer.

The contractor (Fig. 807) contains holes which are complementary in shape to the mandrels. The mandrels being applied to the inner circumferences of the collars, while the contractor must admit the collars themselves, the short taper of the holes in the contractor neces-

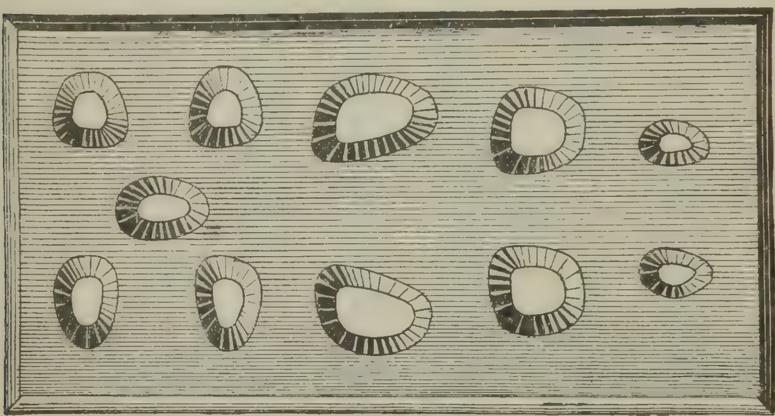


FIG. 807.

sarily covers a somewhat greater range of size than is shown in the mandrels. With this appliance collars can be evenly and accurately reduced in size at the edges, without burring or buckling. The illustration is actual size.

The collar pliers (Fig. 808) are for contouring the collars to shape, one beak being made convex and the other concave to correspond. With this appliance the slightest changes required in the contour of the collars are easily made. About a half inch from the extremity of the concave beak a small bar of flat steel is attached to it by means of a screw. The free end of the bar has a minute projection upon one face, the other being reinforced to fit into the concavity of the beak. In the center of the face of the convex beak is a depression, into which the projection on the steel bar strikes, making a very efficient punch for forming guards or stops to prevent the collars from being

forced too far under the gum. The depression in the convex beak being slightly larger than the projection or punch, the metal is not cut through, but merely raised on the side opposite to the punch. The punch attachment, being pivoted, can be swung to one side when not in use.

Fig. 809 is a mallet or hammer, with steel face and horn peen. The handle is 9 inches long.

One of the appliances required is a lead anvil,

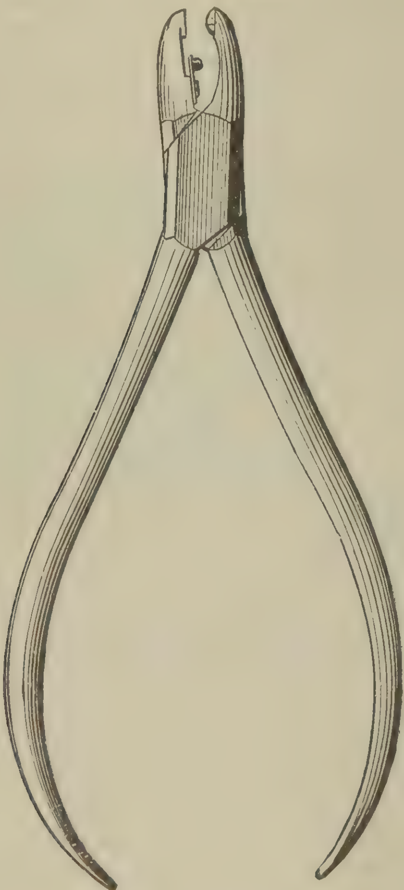


FIG. 808.

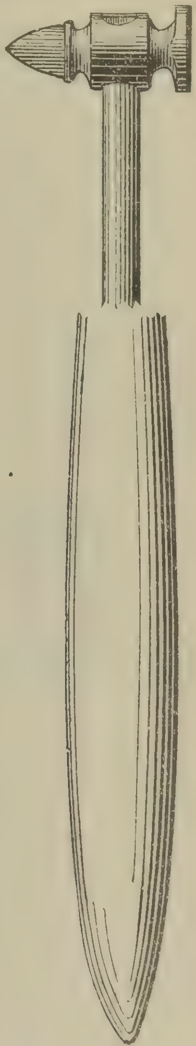


FIG. 809.

which, being only a piece of soft lead, say 2 x 3 inches and an inch thick, is not illustrated. The female die of an ordinary case will answer very well.

To illustrate the uses of these appliances, take a case in which two

inferior bicuspids of the left side are missing, and the crowns of the cuspid and first molar so badly decayed that the probabilities are that they will soon fall victims to the forceps. The old-time way would have been to extract the molar and cuspids, and make a partial plate. Examination, however, shows that the roots of these two teeth are in good condition, affording an excellent opportunity for the construction of a piece of bridge-work.

With a corundum point or rotary file, cut off the remaining portions of the crowns level with the gum margins. Prepare the roots in any of the well-known ways, thoroughly cleansing the apical portions and filling them with whatever material is desired, being careful only that the work is well done. For the better retention of the filling material to be placed in the pulp-chamber, retaining-grooves can be made or retaining-posts inserted. Take a piece of binding-wire (No. 26, American gauge), say 2½ inches long, pass it around the neck of the molar stump, cross the free ends, and, holding the wire in place with one finger, twist the ends with a pair of flat-nose pliers until the wire clasps the neck closely at every point (Fig. 810). Where there are

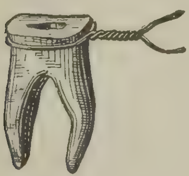


FIG. 810.

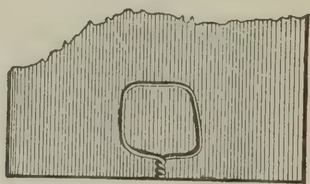


FIG. 811.

irregularities in the contour of the tooth, it is necessary to press the wire into them with an approximal burnisher. It is obvious that the ring thus formed will show the exact size and shape of the neck of the tooth. Remove the ring carefully, lay it on the lead anvil, put over it a piece of flat metal, and with a smart blow from a hammer drive the wire into the lead (Fig. 811). Upon removing the wire an exact impression of the ring will be left in the lead anvil. (This part of the work, as, indeed, all others, should be done carefully as described. The wire ring may be driven into the lead by a direct blow of the hammer face, but the blow might not strike equally, and the interposition of the flat metal held level insures an even impression. A piece of an old file is best, as the file-cuts keep the wire from slipping.)

Next, cut the wire ring at the lap, straighten out the wire, and select a suitable collar by comparing the length of the wire with the straight lines, which correspond in length to the inside diameters of the various sizes. Should none of these correspond exactly, take prefer-

ably the next size smaller. It will be remembered that the collars are No. 30 in thickness, while the wire with which the conformation is secured is No. 26. This difference permits the collar when contoured to shape to enter the lead impression readily, a decided advantage in fitting. Having selected the collar, fit it to mandrel No. 5, with the peen of the hammer, holding it upon the lead anvil, and using a slight pushing force to help in stretching and forming it (Fig. 812). Having driven the collar to form, remove it from the mandrel and try in the lead impression. If it does not fit exactly, return it to the mandrel and stretch it a little, when it will usually fit perfectly, as the mandrels have been designed carefully to the average shapes which obtain in the great majority of tooth-necks. In the exceptional cases where the collar does not fit it can be readily contoured to the exact shape with a pair of flat-nose pliers. Of course, if it fits the impression in the lead, it will fit the neck of the tooth, always provided the measurement and the impression have been carefully made.

If the collar or band has been accidentally stretched too much, or if for any reason when brought to shape it is too large, its root end

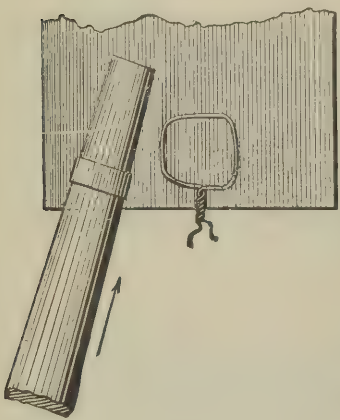


FIG. 812.

FIG. 813.

can easily be reduced to the proper size by the use of the contractor. Place the edge of the collar which is to fit the root in the proper hole; hold it level with a piece of file as in taking the lead impression of the ring, and tapping lightly on the file drive the collar into the plate (Fig. 813) until the proper reduction is made. The collar is next "festooned" to correspond to the shape of the "maxillary" ridge. Lay it, gum edge up, on the lead anvil, and with the piece of flat file and the hammer drive it into the lead. A few cuts with a fine half-round file across the approximal diameter will conform the edges to the surface of the ridge (Fig. 814). Then place the collar in position, and, having ascertained just how far it should go down on the root, remove it, and with the small spring punch in the collar pliers form projections on the inside of the band at the proper points to serve as stops, which, resting on the top of the root, will prevent the

collar from being forced further down upon it than is desirable (Fig. 815).

A collar for the cuspid is then fitted in the same manner, using mandrel No. 6 for shaping, after which the case is ready for the building of the bridge.

Place both collars in position and take an impression of the parts, including the interiors of the excavated pulp-chambers, from which make a cast in the usual way. Bend a short piece of half-round gold or platinum wire into the form of a horse-shoe, the two extremities of which shall fit into the roots of the molar. Then take a longer piece of the same wire, somewhat more than enough to extend from

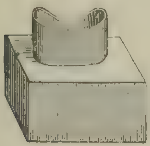


FIG. 814.

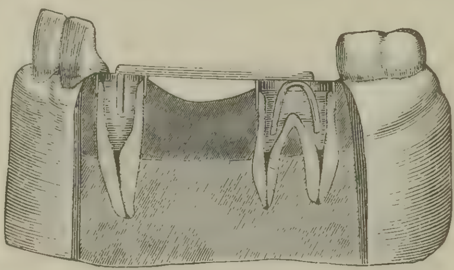


FIG. 816.

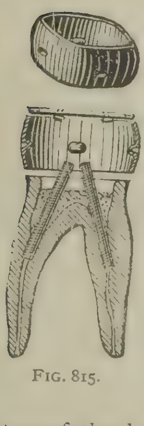


FIG. 815.

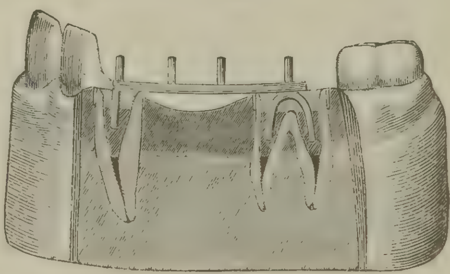


FIG. 817.

the toe of the horse-shoe when in position to the cuspid root; bend one end of it at a right angle, or nearly so, to fit the root of the cuspid, and (cutting off any excess of length) solder the other end to the toe of the horse-shoe. The bar extending between the two roots is the truss of the bridge. Next, place the appliance on the cast (Fig. 816), holding it in position with wax, and select the teeth to take the place of the missing bicuspids and molar. The best form for this purpose is a tooth having holes extending through it vertically from the neck to the grinding surface, similar to the well-known Bonwill crown.

The crowns used should be large enough to fill the space rather tightly, even if their sides have to be flattened slightly to let them in.

If the teeth do not fill the space tightly, a small portion of plastic filling material crowded between them, as mortar between the granite blocks in the arch of a railway bridge, will greatly increase the strength of the work.

After the teeth are ground to fit and the proper length for occlusion is ascertained, the truss is covered with a thin film of wax, upon which the crowns are again pressed to their positions. Upon the removal of the crowns the impression of the holes running through them will be found in the wax. At these points drill holes through the bar with a small twist drill run by the engine, and into these fit and solder the pins for the support of the crowns.

The bridge is now ready to be attached permanently. Set the crowns in position upon their supporting pins to secure the proper alignment. (If the operation were upon the upper jaw they would have to be held with wax). Put into the canals of the supporting roots (the cuspid and first molar) a sufficient quantity of some quick-setting plastic, as oxyphosphate, to about half fill the pulp-chamber, but not enough to prevent the supports of the truss from being forced home. Force the bridge supports to place, and after allowing the filling material to become set remove the crowns. Fill the remainder of the pulp-chamber and the whole of the collar with gold or with amalgam, gutta-percha, oxyphosphate, or any suitable plastic (Fig. 817). Set the crowns permanently, the molar and cuspid first, as this affords greater facility for the trimming off of any excess of the filling material used in the attachment. For attachment of the crowns, gutta-percha is probably the best material, as crowns set with it are readily removed for the correction of any inaccuracies of occlusion or alignment, by grasping them between the beaks, previously warmed, of a pair of universal lower molar forceps. The heat warms the gutta-percha and releases the tooth, which can then be re-set properly. In attaching crowns with gutta-percha the holes in the crowns are first filled with the material, after which the crown is warmed and forced to place. Any of the other plastics ordinarily used in setting Bonwill crowns can be employed at the discretion of the operator. Fig. 818 shows the case completed.

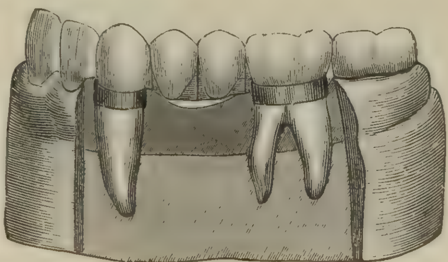


Fig. 818.

In securing the occlusion of a piece of bridge-work it is well to

make the artificial teeth a little short, so that the natural teeth on both sides will meet the first shock of mastication. Nature will correct the occlusion in time by slightly elongating the roots supporting the bridge. If the artificial crowns are permitted to strike the natural teeth from the first, the undue strain upon the two supporting roots may cause soreness and perhaps more serious consequences.

When a sound tooth is to be used as one of the supports of the bridge, a modification of the method just described is necessary. Take a case where it is desired to bridge the space caused by the loss of the right inferior bicuspids and first molar. The crown of the right cuspid is nearly gone, but the root is sound and capable of supporting one end of the bridge. The other end will be attached to the second molar, which is a sound tooth. Prepare and band the cuspid root as before; dress off the second molar crown until it is slightly smaller than the neck, so as to permit a cap to be telescoped over it, and take the measure of the crown with the binding-wire. Select a suitable seamless collar of sufficient width to extend from the neck to a little beyond the grinding surface, and drive it up on the proper mandrel to get the general shape, but not the full size required to fit the tooth, leaving it so that the edge having the larger circumference will just pass over the end of the crown; place the collar on the tooth, and with a block of wood and the mallet tap it to place just beyond the free margin of the gum. This method will make a close fit, as the collar will readily stretch all that is necessary. With a sharp-pointed instrument mark the length of the crown, remove the collar, and cut it to the proper width as indicated. Then in a piece of gold plate of the thickness used for caps form four little depressions of the general character of an impression of the molar cusps. An easy way to do this is to lay the plate on the lead anvil; then with the ball on the end of an ordinary socket-handle and the hammer the depressions are made in a moment. Set the collar on the plate, borax it, charge with solder, and heat till the solder flows. Cut off the surplus plate, and a perfect cap for the molar is made. Place it on the tooth and take an impression, and thereafter proceed as before directed to make the truss of the bridge and mount the teeth, except that in this case the posterior end of the truss is to be soldered to the molar cap. For the

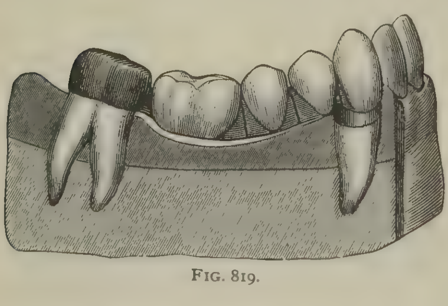


Fig. 819.

final attachment place a little oxyphosphate or any other plastic filling material in the cap to secure it firmly (Fig. 819), first cutting a slot in the crown end of the cap for the escape of the excess of material. Pressure upon the filling material hastens its hardening.

Detachable Bridge-work.

A description of two or three methods of constructing detachable bridges will suffice to indicate the general principles involved. Having these, each operator will find it an easy task to devise the modifications necessary to adapt a method to individual cases.

The first method is especially applicable to cases where both ends of the bridge are attached to roots—as, for example, the inferior cuspid and second molar roots of the right side, the intervening teeth having been lost. The operation is conducted as described in the first case of fixed bridge-work down to the construction of the truss, for which in this method square gold wire is used. Having cut the wire of the proper length, lay it upon a piece of gold plate (about No. 29, American gauge) of the same length and full three times as wide, and placing the two upon the lead anvil, with a hammer and the piece of file before used drive them into the lead. This will form the plate into what we may call an open trunk, which fits the square wire. Remove the two from the lead together, and, without separating them, curve to the proper shape to form the truss. Grind crowns having vertical holes, like the Bonwill, to fit, and having determined the proper points for the supporting pins, by the method already described, drill through both trunk and bar at these points. Separate the bar from the trunk, and fit and solder pins to the bar. Construct small tubes to fit the pins, ream out the holes through the trunk to admit them, and set the tubes with solder in the enlarged holes (Fig. 820). Fix the crowns permanently upon the tubes. They may be mounted in any of the approved ways, by vulcanizing or by the use of a plastic filling material. When they are firmly set, place the trunk with the teeth upon the bar, and anchor permanently as already described. Fig. 821 shows the completed work.

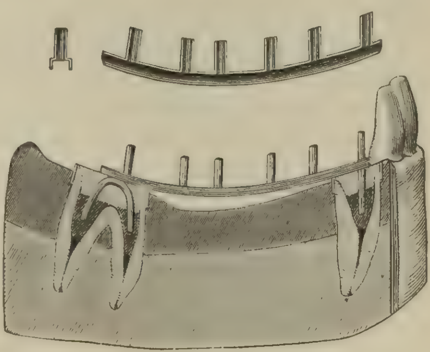


Fig. 820.

In this method the truss consists of the bar and the open trunk which covers three sides of it. The bar is, of course, permanently attached to the roots of the molar and cuspid, but the trunk with the teeth can be removed at any time.

The second method of constructing a detachable bridge is applicable to cases where one or both of the supports or piers are sound teeth.

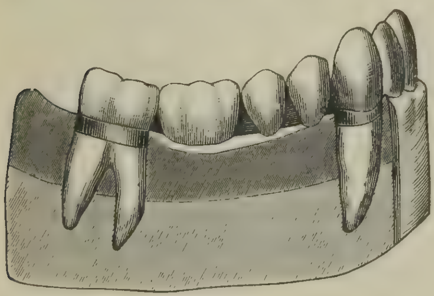


FIG. 821.

In the case adduced for illustration the right inferior cuspid crown was decayed, and both of the bicuspids and the first molar were absent. The supports for the bridge were the sound second molar and the cuspid root. After the cuspid root was prepared and banded, the crown of the molar was reduced very slightly,—not sufficient to destroy the enamel, but just enough to permit a collar properly fitted to pass over it. A collar somewhat wider than the length of the crown from grinding surface to neck was fitted and cut to the proper width. Two lugs were then soldered upon the anterior and posterior sides and bent to fit into the approximal fissures which were slightly cut out to admit them. An impression was taken, the collar coming away in the plaster, and a cast was made with the collar in position. A coned tube was then made for the root of the cuspid and a coned pin fitted into it. A truss of half-round wire was made, to which the coned pin and the molar collar were soldered (Fig. 822). A half-clasp to grasp the lateral was next soldered to the end of the truss to be supported by the cuspid. The object of this clasp was to guard against the teeth being thrown out of proper alignment by the force of mastication. Bonwill crowns were then vulcanized to the truss, after their supporting pins had been fitted and soldered to it. (Countersunk crowns can be used as well in the same way. Plain plate teeth may also be used in this style of work, in which event they are to be soldered to the truss.) The bridge was then ready to be set, which was accomplished in the following manner: The cuspid root was nearly filled with oxyphosphate, and the coned tube was placed upon the pin. The band was put on the molar, and the coned pin with the tube upon it was forced into the plastic in the cuspid. As soon as this became set, the tube was held permanently, while the bridge itself could be removed whenever desired (Fig. 823).

This method of fixing the tube allows considerable range in its

adjustment. In soldering the coned pin to the truss, care should be taken to set it at an angle exactly parallel to the axis of the molar; otherwise there will be difficulty in removing the bridge.

The third style of detachable bridge-work to be described involves the use of cusp crowns (Fig. 824) for supporting posts and piers. Suppose a case where both ends of the bridge are to be attached to inferior cuspid and second molar roots, the intervening teeth having been lost; the bridge is, therefore, required to extend from the right

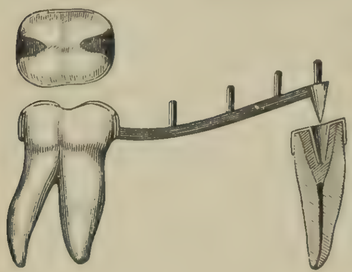


FIG. 822.

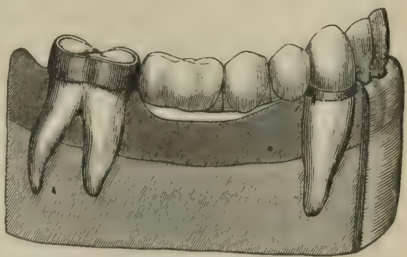


FIG. 823.

inferior cuspid to the right inferior second molar, with only the roots of the two teeth named as supports. Prepare the roots and pulp-chambers. Set screw-posts into the dentine for anchorage or as retaining-pins, and fit the collars, using sizes wide enough to form the walls of the crowns. Fill the pulp-chamber and about two-thirds of the depth of the collars with a plastic filling material, packing it well around the retaining posts. Select suitable cusp crowns for the molar and cuspid and place them in the ends of the bands to ascertain the

FIG. 824.

occlusion. If too long, shorten the cusps or reduce the bands with engine corundums or rotary files, and when the correct articulation is found form a small, square shoulder in the lingual edge of the cuspid and in the posterior grinding surface of the molar. Fill the remaining portion of the collars with plastic mixed somewhat thinner than the first lot, and set the cusp crowns in position. If there are antagonizing teeth the mere closing of the patient's jaws will force the crowns to place. If there are no antagonizing teeth the crowns can

be readily tapped to place with the mallet, using a piece of wood as a driver. Allow the filling material to set firmly, trimming off any excess which may exude around the collars.

Bridge supports or piers constructed on this plan are strong and durable, and likely to withstand any strain. Take an impression, and proceed to fit seamless collars to telescope over those already set upon the cuspid and second molar roots. It will be remembered that these collars are so made that each size telescopes into the next higher series. If the proper sizes are selected for the outside or female bands, the work of fitting is readily and quickly accomplished, forming tubes which slide easily over the supporting piers, and at the same time fit closely. It is only necessary to take care in shaping the tubes not to drive them too far up on the mandrels, and thus stretch them so as to destroy the fit. To the outer end of each of the tubes solder a small

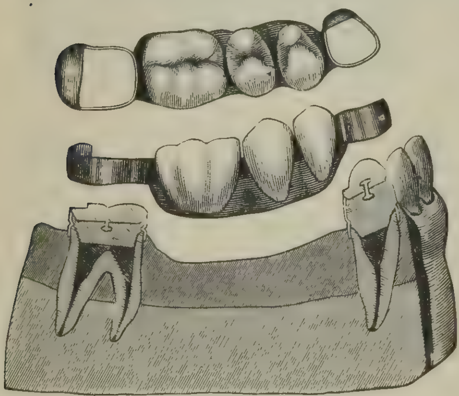


FIG. 825.

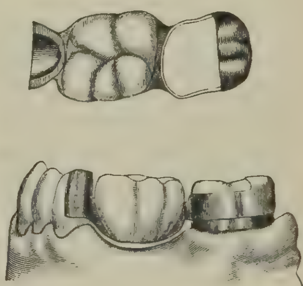


FIG. 826.

piece of gold plate, forming partial caps so placed as to rest when in position upon the shoulders previously cut in the cusp crowns. Adjust a truss bar of half round gold wire, to the ends of which solder the tubes (Fig. 825). The truss is now ready for the teeth, which may be of any of the forms used for this purpose, and they may be attached to the bar in any way desired. One of the strongest attachments is vulcanite.

An easy modification of the plan just described is readily adapted to cases where only a small space is to be filled and one end of the bridge is to be supported by a sound tooth. Thus, suppose it is desired to bridge a space formerly occupied by the two inferior left bicuspids, the crown of the first molar being a mere shell. The operation would be essentially the same as in the previous case, except that the sound cuspid would be utilized for one of the piers as follows:

Fit a seamless collar, cut out a portion of it so that it will embrace only about two-thirds of the cuspid crown, and solder a partial cap or cover to it, as illustrated in Fig. 826. Or, if deemed preferable, the cuspid may be separated from the lateral incisor with the corundum disc and the collar allowed to embrace the whole crown.

The great desideratum in constructing a piece of bridge-work is, of course, the securing of perfect usefulness in mastication and speech, combined with absolute comfort and cleanliness. The closer a bridge approaches that condition where its wearer loses consciousness of its presence in his mouth, the nearer perfection it is. Scarcely less important, however, is the necessity of providing for repair. Accidents will occur, and the system which superadds to usefulness, comfort and beauty, ready facilities for repairing breakages, is by so much superior to those which make no such provision. A crown broken from a bridge constructed by any of the methods above described can be easily substituted, and the piece when repaired will be as strong and serviceable as it was originally.

It has not been deemed necessary to detail the construction of a single crown separately, as all the steps are included in the building of bridges, which have been described minutely. Porcelain cusps of the general form illustrated in Fig. 827 have been designed specially for these cases. In mounting them the gold band is cut away on the buccal side as shown in Fig. 828 to permit the porcelain to show.

Dr. C. M. Richmond, of New York City, in making removable dentures of the entirely soldered kind, employs a zinc die made from a cast of the anchor tooth with its cap on. He makes of crown metal (platinum faced with gold) a collar somewhat smaller than the tooth-cap, and deep enough to reach from the gum to about a sixteenth of an inch above the cap. He then drives the die into the collar so far that the extra sixteenth of an inch can be hammered over and burnished down on the die-end to form a flanged collar. Outside of this, in the same manner, he forms another flanged collar, and then solders the two together, thus obtaining a close-fitting stiff collar, that will not stretch in being telescoped on and off the anchorage, and is kept by the flange from being forced too far over the tooth-cap. A denture of this kind is illustrated in Fig. 829, which also shows his post and roof device in another form than that previously described.

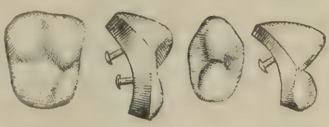


FIG. 827.

It may be well to add that, in the use of an impression cup for holding the plaster and sand around the parts to be subsequently removed

from the mouth, the *inside* of the cup should first be slightly oiled, to allow a separation of the cup when the mass is being prepared for the soldering.

A removable bridge-work is suggested by Dr. T. S. Waters, which is described as follows: "The natural molars and bicuspids, one or more of each class, are capped with gold crowns, each molar being double capped, and the outer cap containing two small springs constructed of small strips of elastic metal (gold and platinum), one end of each spring being soldered to the inner surface of the cap near its base at the neck of the crown, and the other end free to press on the side of the inner cap. Such springs retain the outer cap fitting over the inner one on the prepared natural crowns by their pressure on the sides of the inner caps, the latter being cemented to the natural crowns.

"The band for the natural bicuspid crowns has two shoulders on

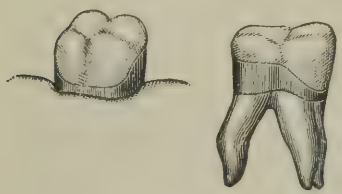


FIG. 828.

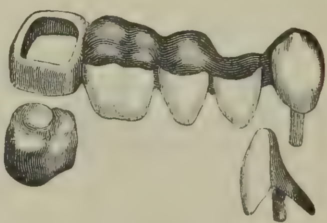


FIG. 829.

the inside which fit into grooves cut in the mesial and distal surfaces of the gold forming the crown."

Dr. James W. Low, the inventor of what is known as the "Low method of bridge-denture," describes it as follows:—

"My experience has convinced me that, as a rule, a tooth firm in the jaw need not be extracted. There are but few exceptions. When the treatment is followed persistently, and proper judgment used, nearly all the partial loss of the teeth can be restored without covering the roof of the mouth, and made as valuable for masticating food as the natural teeth, I am positive, and with less injury to the remaining teeth, than by any other method. The method referred to is that known as the 'Low method,' or bridge-work.

"Bridge-work consists in supplying vacancies between teeth or roots with artificial teeth, attached to the adjoining natural teeth or roots by means of bands or crowns, and held in such position that there is no contact with or pressure on the gums beneath, and thus no opportunity for secretions or other foreign matter to be held there and thereby become offensive.

"There is really but one kind of bridge-work, and but one way to

make bridge-work to insure success. There are many ways of making teeth without plate, but this is not bridge-work. I will here try to explain in detail my manner of making and adjusting bridge-work.

"For the first illustration, as seen in Fig. 830, we have a case where all the teeth have been extracted, except the two cuspids and two second molar roots.

"We first proceed to prepare the roots by crowning. I use gold crowns on the molar teeth, and what is known as the Low crown on the two cuspids.

"The preparation of the two cuspids consists in making the crown ready for adjustment. I always measure the tooth to be crowned with gold with a strip of block tin, 35-thick stub gauge or thereabouts. Place the tin around the tooth, and with pliers carefully measure the full size of the same.

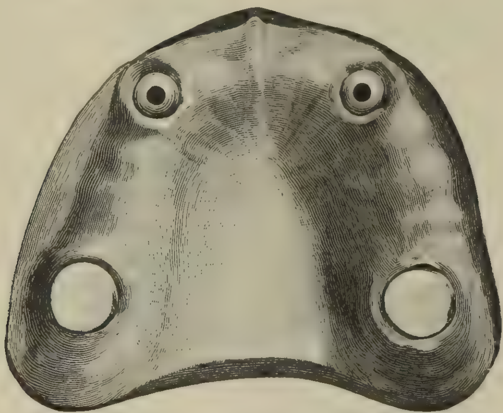


FIG. 830.

"Should you be measuring a tooth, or part of a tooth, on which there are projections, take the engine, and with a stone grind off the same, making a smooth surface, so there will be nothing to interfere with the fitting of the bands properly. After cutting the tin measures by the marks made by the pliers you have the measures ready to make the gold bands by. Cut the bands and bevel the edges, and solder together, and you are ready to fit. After fitting all the bands, and finishing the crowns in the usual way, I place each in position in the mouth, having previously regulated the articulation of each crown as desired, in the process of making. We now take a deep articulation in wax, and impression in plaster of Paris; remove before it gets too hard, and place all the crowns in their positions in the impression; varnish, oil and pour in the usual way; separate the cast from the impression and place in the articulator. Then pour plaster. After the

plaster has hardened, remove the wax and we have the articulation proper, and are ready to select and grind our teeth, having previously selected our shade. My experience has long ago taught me that no porcelain teeth can stand the pressure for bridge-work, the strain on them being twice as great as with teeth on plates, which rest on the gums that give to pressure. In order to prevent breakage of teeth and give strength, I have for many years been making a tooth with gold cusps. I will here describe my manner of doing so. I had some shells of bicuspids and molars made, or rather teeth, without the crown. They can now be found in some of the depots.

"For the first step, I use 28-gauge platinum for a covering of the inside of the shell, or just where you wish gold to flow. Then I bend the pins down to hold the platinum in position, and with a file remove all overlapping platinum to prevent breaking of our tooth in heating. The tooth is made flat on the crown surface with the express intention of restoring with a gold crown. This crown need not be very thick, but should perfectly resemble the cusps on the natural tooth, for the purpose of mastication. As these cusps are not on the market, and every dentist making bridge-work cannot make it in a way to stand, without putting gold cusps on the grinding surface of the bicuspids and molars, I will here describe, for the benefit of those who do not know how to make them, how they can be made with very little trouble. Pick out a natural tooth with cusps the exact shape you wish to have your gold cusps, mix some fire-clay in a thick paste, then press your tooth into it a little deeper than you wish the cusps. Having made the proper impression, remove the tooth, and set the impression over the gas stove to dry. After it is dried and reasonably hot, lay your pieces of gold in the impression and, with a blowpipe, melt them. When melted, press with a piece of steel on the gold till cool. This mold will do to make many from. If you have not the fire-clay and can get charcoal that is burned from fine-grained wood, and is soft, you can simply press your tooth into the charcoal and melt in the same way, or you can carve your teeth as you desire in a block of carbon. Of course the little steel dies are handier, as we can swedge up our gold cusps in them, either solid or thin.

"Having described our manner of making the cusps, we will now return to the manner of finishing our tooth. We left off by saying we covered the inside and bent down the pins and filed off the overlapping platinum. We now place the cusp on the top of the tooth, and place in the position desired, holding it there with wax, and with a spatula trim the wax the exact shape we wish our tooth to be, V-shape, tapering from the crown down. We now encase in plaster and sand, which gives us a box. When hard, remove the wax and place

over the stove, and when sufficiently dry fill in with coin gold, using the blowpipe to melt it in a solid mass, and then our tooth is ready to file up and place in position on the articulator. Fig. 831 shows the tooth in this condition.

"After our teeth are all arranged we hold the same in position with wax, remove from the articulator, encase with plaster and sand or asbestos in the usual way. That we may have a strong case, I always use platinum wire between each tooth, and then proceed to heat and solder. Be sure that all the gold cusps are so arranged that you can

FIG. 831.

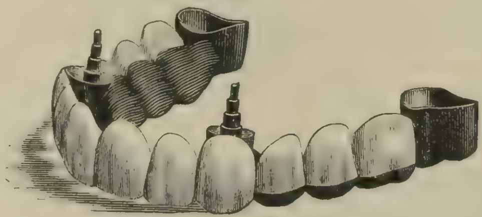


FIG. 832.

get all soldered together, as this gives us great strength. My formula for solder, which I have used for many years and which will be found very easy-flowing and almost the exact color of the gold you are using, is as follows: Always figure from the carat of gold you are working. Take one pennyweight coin gold, two grains of copper, and four of silver. We now have our case soldered; after filing as desired, commence to finish with felt wheels and pumice stone, after which we use rough buff wheels. We are now ready to adjust in the mouth. In Fig. 832 we see the case ready for adjustment.

"Have the assistant dry all the teeth or roots to be operated upon while you are mixing the cement. Be sure and use a kind which does not harden very rapidly, or your cement will set before you get your teeth adjusted. Use sufficient cement to fill all the gold crowns perfectly when the case is driven to place. Moisten the step plugs and cap with cement, touching every portion, and with an instrument place a little cement in the bottom of the cavity. We now adjust our case, using the little rotor for the low crowns, and a piece of ivory for driving on the gold crowns. Fig. 833 represents the case when in position.

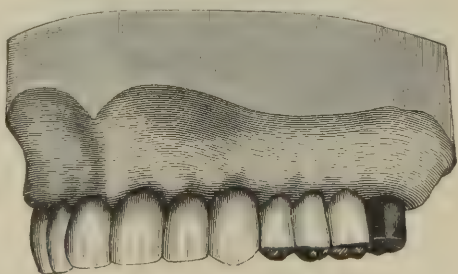


FIG. 833.

"It will be seen by looking at the previous cut (Fig. 832) that the teeth, after having been soldered, are all spaced fully one-third of the distance from the place of contact with the gums and the grinding surface of the teeth, so that secretions could not possibly lodge there. I have given you a description of my manner of making a full upper case of bridge-work where there are roots to be crowned to support the bridge. I will now describe my manner of operating upon a case where the four centrals are missing, as seen in Fig. 834. To supply these four teeth where the cuspids are intact, I use a gold band.

"I first measure the tooth with strips of tin and make the gold bands as before described, cut out the outside lower portion of the band before beginning to fit. In fitting, as the band is being driven down, cut away any of the band that touches the gum before all touches; never drive the band under the gum, as inflammation would probably follow.

"I mention this, as I have seen many attempts to get rid of the band by driving up under the gums and cutting them out on the front, until

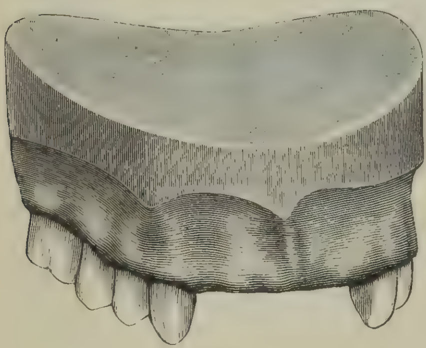


FIG. 834.

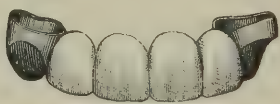


FIG. 835.

they were too narrow for strength. It is hard work to make something out of nothing. The bands should be heavy and strong, and the patient made to understand that if he expects to get rid of the annoyance of the plate he must sacrifice his dislike to showing gold. After driving the bands up close to the margin of the gums, as the cuspid teeth are very tapering, the bands will have to be taken in at the bottom. To do this I slit the band about a third of its length up, then place it on the tooth again, lap it over enough to bring it to a close fit, and then take it off and solder.

"Continue taking it in wherever it does not perfectly fit the tooth, and after a good fit is obtained proceed as before described by taking an articulation and impression. In adjusting first try the case on to see that it fits and that the articulation is all right. Fig. 835 shows the case ready for adjustment.

"Next, have the assistant dry the teeth upon which the bands are going, and then mix your cement. This should be mixed to about

the consistency of thick cream. It must be neither too thick nor too thin, or the adhesion will not be strong enough to hold. Cover your teeth with cement and then the inside of the bands. Place these on the teeth and carefully mallet up into position. For this purpose I use a steel instrument with a crease or groove in the end. The teeth must be kept dry after the case is in position until the cement is well set. After this is done bevel the edges of the bands and burnish close to the teeth, and if properly done they will be made to resemble gold fillings.

"In Fig. 836 we have the case completed.

"I am aware that in a case like this, porcelain crowns instead of gold bands could be used, and I should consider it much preferable to do so where we have roots or unsound teeth to operate upon, but do not advise the destroying of nerves where the teeth are intact to supply such a case with crowns, as the bands will answer every purpose for many years.

"If they should give out in after years, the roots can then be crowned. I have many of these cases that have been in use seven and eight years, some of which have never loosened, and some I have reset nearly every year. I always impress upon the patient the necessity of having them reset immediately, should they become loose, and advise them to have their cases examined at least once a year. Should parties insist upon having crowns used to supply a case like the one just described on perfectly sound teeth, I should begin by using an aluminum disc, with corundum, cutting deep as possible, both on the labial and lingual sides. Then use the excising forceps. This can be done under the influence of an anesthetic or otherwise. It is not by any means so painful an operation as one would think. If the nerve does not come out with the piece of tooth cut off, I take a piece of orange wood which I have previously cut the proper shape to drive into the nerve canal. I place it in creosote and let it soak a few minutes before beginning to operate. Immediately after severing the tooth, drive this into the canal, then remove, and dip in creosote and drive in again. This will perfectly fill the nerve canal; all sensitiveness will disappear, and you can begin to operate at once. I do not

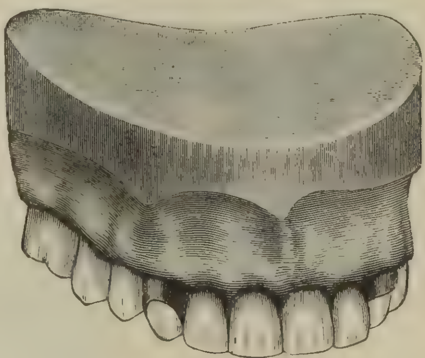


Fig. 836.

recommend this treatment for sound teeth, but I have treated many exposed nerves in this way; also many teeth broken by accident, and think this the most satisfactory way to dispose of such cases. I have never had any unfavorable results follow after operating upon teeth in this way, and I can hardly say as much in favor of any other treatment. I speak of this manner of treating exposed nerves as one of the operations that sometimes become necessary in adjusting a bridge properly. I do not claim any originality in this mode of treatment. I know several dentists who use this method, all of whom report satisfactory results. We now have Fig. 837, showing the roots prepared to receive the case.

FIG. 837.

"I have many of these cases in use that are giving entire satisfaction. The instrument selected for preparing these roots should be one with small inside cutters and large bevelers, so as not to cut away any more tooth-substance than possible.

"Fig. 838 represents the case ready for adjustment.

"Fig. 839 represents the case after adjustment.

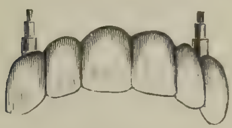


FIG. 838.

FIG. 839.

"In this article I have described my manner of making teeth for bridge-work, and I am now using a tooth made expressly for this work.

"The following, Fig. 840, shows us a socket. These are ready made in various sizes in bicuspids and molars with corresponding shells.

"Figs. 841 and 842 represent the shells placed in sockets. Fig. 841 is a molar tooth showing the shell in position, and 842 is a central reversed.

"Fig. 843 represents the socket as made for the four central and two cuspid teeth. The advantage of these teeth can readily be seen, not only for bridge-work but all gold plates. A tooth, if broken, can readily be replaced without removing the bridge or cracking by soldering, and with only a small expense.

"Fig. 844 represents the shell placed in position in the socket,

FIG. 840.

FIG. 841.

FIG. 842.

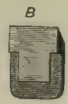


FIG. 843.

FIG. 844.

which can be used for bridge- or crown-work, and will greatly reduce the labor in making either."

Dr. G. W. Melotte describes his system of bridge-denture as follows:—*

"Fig. 845 illustrates a case for the supply of a lateral and a bicuspid. In this instance the cuspid could be cut off, and the root collared and capped in combination with a pin entering the enlarged pulp-canal; but, as there may be grounds for objection to cutting off sound teeth, I obviate the necessity by cutting a shoulder on the lingual portion of the cuspid, and suitably shaping its sides to permit a close-fitting collar just under the free margin of the gum. A narrow strip of pure pattern tin, bent tight around the tooth-neck, and cut through with a knife at the lap on the labial surface, will serve as a measure for the length of a strip of 22-carat gold plate, No. 29 thick, and as wide as the length of the distal side of the cuspid The ends of the gold are then squared, and with round-nosed pliers brought evenly together, to be held in flush contact by the soldering-clamp shown in Fig. 846. The soldered collar, with its joint side inward, is then adjusted on the tooth as accurately as possible, giving slight blows with a mallet until the collar touches the gum, when it should be marked to indicate the necessary trimming to conform it to the gum contour. After it has been

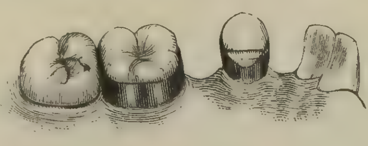


FIG. 845.

* *Dental Cosmos*, Decem. No., 1886.

thus trimmed, the edges beveled, the labial part swelled with contouring pliers, and the lingual part cut down to about one-tenth of an inch in width, the collar is again driven on, and will appear as seen in Fig. 845. A stump corundum wheel is then used to grind a shoulder on the lingual surface of the tooth, grinding also the edges of the collar flush with the shoulder. The collar is again removed, and a piece of thin platinum plate, about No. 32, sufficient to cover the lingual surface of the tooth, is caught on the lingual edge of the collar by the least bit of solder, and all put in place on the cuspid (see Fig. 847). The platinum should now be burnished on to the shoulder, and over the tooth and collar to the extent shown by the lines in Fig. 847. After trimming to those lines, and careful replacement and burnishing on the tooth, the collar and half cap are removed, filled with wet plaster and sand, and the platinum soldered to the gold. It is then placed on the tooth, burnished into all the inequalities of the tooth, very carefully removed, invested, and enough

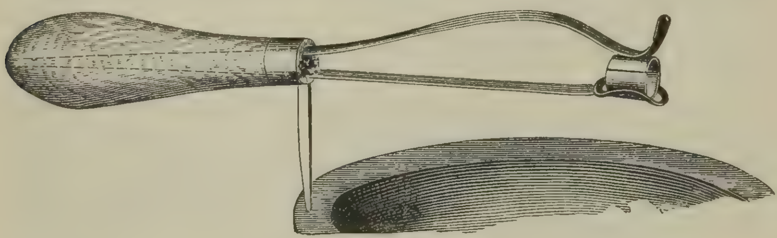


FIG. 846.

solder flowed over the platinum to cover and give it strength. Fig. 848 shows it complete on the cuspid.

"I have feared that a detailed statement would imply a long and tedious process, but I have often made such collars in less than an hour, and in any case time must be made subservient to exactness of fit and adaptation to the end in view.

"In the preparation for fitting a collar on the first molar (Fig. 845), I should have wedged or otherwise separated it from the second molar, so that a piece of sheet brass might be put in place, as shown by Fig. 849, and an impression taken in plaster, which if allowed to get hard would bring away the metal. If not, it could be replaced in the plaster. Melted fusible metal, when near the cooling point, is then poured into the impression, and when cold will allow the safe removal of both the plaster and the metal strip. On this metal model a collar can be formed that will accurately fit the molar, as seen in Fig. 845. If the molar has no antagonist, a cap may at once be struck up on the model, but if there be an antagonist the cusps of

the natural molar should be removed by grinding at points where the occluding tooth will admit of sufficient thickness of the gold cap. An exact copy of the ground cusps can then be made in less than five minutes, by the use of moldine with its accessories, and the process is as follows: Make the tooth perfectly dry. Put the collar on it. Nearly fill the cup (Fig. 851) with moldine, and coat it with soapstone powder. Press the compound on the tooth and collar firmly to

FIG. 847.

FIG. 848.

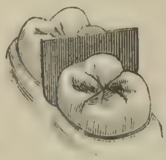


FIG. 849.

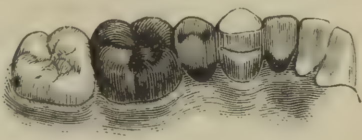


FIG. 850.

about one-fourth the depth of the tooth. Carefully remove the cup; trim off any overhanging material, and place the rubber ring over the cup to about one-half the depth of the ring. Melt the fusible metal and pour it, as cool as it will run from the iron ladle. As soon as the metal is hard, remove it with the ring (Fig. 852), taking care not to impair the impression, which can be used again if the die is found imperfect or gets injured in use. Place the die and ring in cold water, to remain until quite cooled. While the die is wet and held over a basin of water, pour into the ring fusible metal which has been

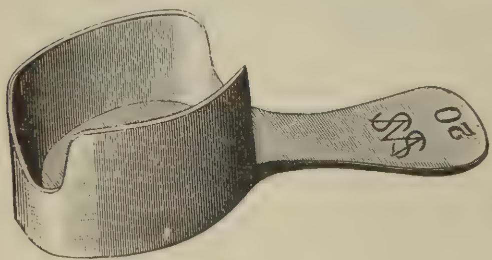


FIG. 851.

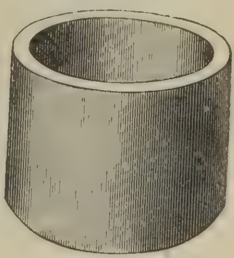


FIG. 852.

stirred until it begins to granulate, and quickly immerse all in the water. The die and counter-die should separate readily by tapping them with a hammer, but if they stick, others can be quickly made from the same impression, by the same method, using more care. With this die and its counter-die, a piece of No. 29 or 30 gold plate is swaged to fit perfectly the cusps and collar, which, when removed, can be held to its place on the cap by the soldering-clamp, using spring pressure enough merely to hold them together for careful

soldering with the pointed flame so as not to unsolder the collar. The seamless collars are excellent when care is used in selecting the proper size, as directed on the diagram.

"The caps being in place on the cuspid and molar, an impression is taken with plaster; the caps accurately set in the impression, and hard wax melted with a hot spatula around the edges of the caps. The impression is then thoroughly coated with sandarac varnish, after which it is dipped for a moment in water, and filled with a wet mixture of one part marble-dust with two parts of plaster; using great care to perfectly fill the caps and molds of the teeth. Wait until this mixture has become quite hard; remove the cup, and with a suitable knife chip off the plaster without marring the cast; secure a good articulating impression, and transfer it to the cast to obtain an exact reproduction of the relative occlusions of all the teeth involved. With such an articulation in hand, and with the means already described for swaging gold or platinum plate to fit the cusps and articulating surfaces of either the natural or artificial teeth, it should be within the capacity of any competent dentist to complete a suitable bridge; although there are practical points that can only be imparted by clinical instruction and actual demonstration in the mouth. Such a bridge is shown in position by Fig. 850."

Dr. R. Walter Starr describes a bridge-denture which can be removed for repair in case of injury, as follows:—*

"It will doubtless be admitted that in some cases bridge-work has advantages over the ordinary plates for partial dentures. It will also be conceded that the security and permanence of the fixture enhances its practical value to the patient so long as all goes well. But if for any reason it shall become necessary to remove the bridge, for repairs or treatment of the roots used as anchorage, its fixedness proves a serious objection.

"In the endeavor to provide a remedy for this defect, the structures now to be described originated, and will, it is hoped, be found applicable in many instances in such cases as are typified by the accompanying illustrations.

"In the construction of such bridges the first thing to be done is to grind with engine-corundums the overhanging edges and sides of the teeth which are to serve as abutments, so that the crown-ends shall be slightly smaller but of the same shape as their necks. This can be demonstrated by bending a piece of fine binding-wire around the tooth-neck, and twisting the free ends together to form a close-fitting loop, which, if the tooth has been suitably shaped, may be

* *Dental Cosmos*, vol. xxviii.

slipped from the tooth without changing the form of the loop, thus giving an exact outline of its form and size. Such a loop is shown in Fig. 853. The loop is then laid upon an anvil, and the squared end of a short piece of wood placed over the wire, and a blow struck to drive the loop into the wood as a guide in shaping the wood to the precise size and form of the inside of the loop, as in Fig. 854. The free end of this wooden mandrel must subsequently be slightly reduced so as to conform exactly to the natural crown. In lieu of this method an exact impression of the tooth may be taken in plaster to serve as a mandrel. About a sixteenth of an inch is then ground from the occluding cusps of the abutment teeth, and an impression taken of the teeth and surrounding parts, to obtain a model, as shown in Fig. 857. A piece of gold plate, say 22-carat fine, number 30 gauge, is cut and fitted closely around the mandrel, and its ends soldered to make a collar, as in Fig. 855. This is laid with the crown end upon a piece of lead, and a piece of wood or metal laid over it and struck with a hammer to drive the collar

FIG. 853.

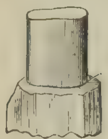


FIG. 854.

FIG. 855.

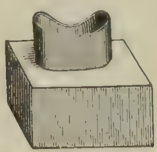


FIG. 856.

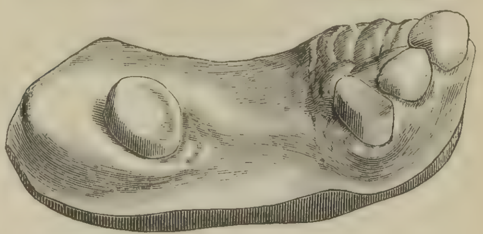


FIG. 857.

into the lead so as to hold it securely and maintain its form, while with a smooth, half-round file the neck end is shaped as seen in Fig. 856. The other end of the collar is then cut so that the depth of the collar shall a little exceed the visible length of the tooth, thus allowing the neck end when placed upon the tooth to pass beneath the free edge of the gum. A piece of gold plate, either plain or struck up in cusp form, is then soldered to the crown end of the collar. If a seamless collar is used it can be laid upon the plate for soldering without an investment or a clamping wire. A piece of thin platinum plate, No. 36 gauge, a little wider than the space to be covered with the teeth, is fitted and burnished over the space between the abutment teeth, which have been so trimmed that the caps described will slide on and off easily. These caps are now cemented to the platinum plate, and collars made and fitted to properly fill the space between the abutment teeth. They are held in contact with each other and with the platinum plate

by running melted white wax in and between them. The whole piece may then be transferred from the model to the mouth, and stiff mixed plaster and sand pressed into and over the collars and caps. When the plaster has set the mass may be removed, trimmed, and the wax melted away with a result as shown in Fig. 858. The lines of contact of the collars with each other, with the caps, and with the plate are to be neatly soldered, when the investment may be removed, leaving the bridge as shown by Fig. 859. The free edges of the plate may then be trimmed to the margins of the collars or caps, and the whole denture polished. The bridge may now be slipped on and

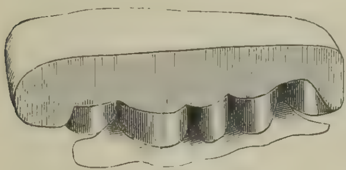


FIG. 858.

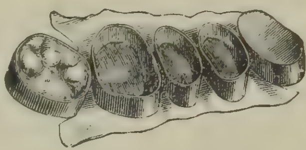


FIG. 859.

FIG. 860.

off the natural abutment teeth with just enough of friction to retain the denture in position and yet allow of its ready removal.

"Suitable cusp-crowns (see Fig. 860) are now selected, the cups partly filled with wax, and the cusps placed in position. The denture is then tried in the mouth and the proper occlusion obtained by grinding or filing the edges of the cups. The piece is now to be thoroughly cleansed and dried; the cups nearly filled with insoluble cement, or hot gutta-percha; the cusp crowns set in the cups; the bridge put quickly in place, and the patient directed to firmly and repeatedly close the jaws to properly determine the occlusion. It will be found best to place a piece of paper the thickness of a postal card over the porcelain cusps when forcing the denture to place, so as to insure that they shall be a little short, and thus avoid irritation of the anchorage teeth in mastication. These anchorage teeth or roots will in time elongate and form a close occlusion.

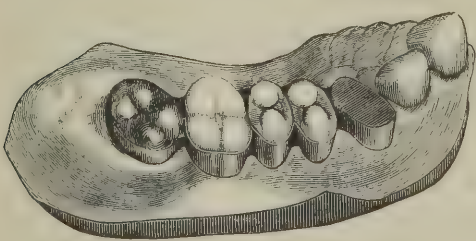


FIG. 861.

"When the cement is properly hardened the piece may be removed. A hole should now be drilled through the metal caps to allow escape of surplus filling material. A small quantity of gutta-percha thoroughly

warmed should now be placed in the caps, and with a piece of card placed between them and the occluding teeth, the caps should be forced home.

"The complete case is represented in Fig. 861.

"The bridge may at any time be removed with warmed forceps beaks held long enough on the caps to soften the gutta-percha. The cusp crowns may be removed, if desired, by the same method and replaced without detaching the bridge.

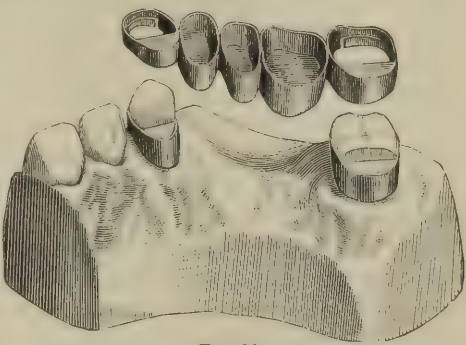


FIG. 862.

"A modified bridge is shown in Fig. 862. It will be observed that collars have been firmly fixed with cement or gutta-percha on the abutment teeth, which have their occluding surfaces ground flat on their inner aspects, so that the partial cap shown may thus prevent the telescoping collars from being forced too far down on the teeth. By means of a frame saw a narrow tongue is cut on the outer face of each telescoping collar, the free portion serving as a spring clasp to hold the bridge securely on the abutment teeth and still allow the removal of the piece whenever so desired. Fig. 863 shows such a bridge in

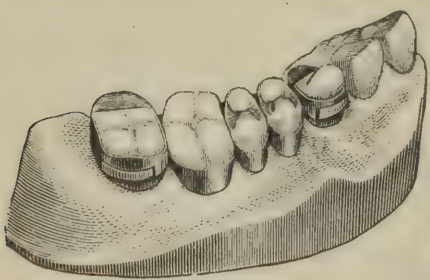


FIG. 863.

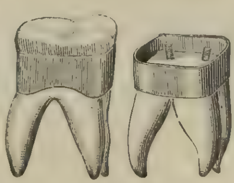


FIG. 864.

FIG. 865.

place. It is obvious that if in this instance the roots only of the cuspid and second molar had been present, they could, by means of the collar and cusp crown devices, have been put in shape to serve as abutment teeth for the telescoping bridge shown in Figs. 862 and 863. The second molar roots so crowned are seen in Fig. 864. When it is desirable to show the faces of the porcelains to a greater degree, the collars may be cut away on the buccal sides and the

countersunk crowns be used as illustrated by Fig. 865. The platinum base may either rest broadly upon the gums or be sloped so that only the buccal border shall touch the gums, or it may be so shaped as to be entirely free from the gum. This is done by building upon the plaster cast, and bending the platinum plate and shaping the gold tubes to the surface so made, depending wholly for support on the abutment teeth or roots.

"Briefly stated, the points of excellence in this bridge are strength, lightness, avoidance of liability to breakage of the porcelain in soldering, ease of construction and adaptation, and the facility with which it may be reorganized, or for any reason be removed and replaced. This last feature is of special value in the not infrequent event of subsequent alveolar abscess, for in cases such as are shown in Fig. 861 the bridge may be removed, the involved teeth drilled, medicaments applied, the bridge replaced, and this process repeated without depriving the patient of the use of the denture."

In the *Dental Cosmos*, Dr. Dexter describes a removable-bridge denture or "cap-plate," as follows:—

"Take a case where, on the lower jaw, there are standing in the mouth a third molar, a canine, and first bicuspid on each side—six teeth in all. These teeth are shortened by breakage and mastication, so that the upper incisors close to within an eighth of an inch of the gum line between the canines; added to this, they are so tipped and twisted in their places as to make it very difficult to properly adapt an ordinary denture to the spaces between them; and, lastly, let the patient evince entire abhorrence of, and a fixed resolution not to permit, the resting or pressure of any appliance upon his gum tissue. Such a case is the one for which I have constructed this cap-plate. Such cases are often treated by building up or down the natural teeth with gold, in order to open the bite, and then replacing lost teeth with an ordinary plate. My apparatus, however, accomplishes both these desiderata in one operation, while simultaneously avoiding any and all pressure upon or irritation of the gum.

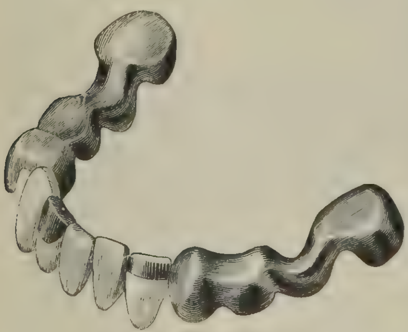


FIG. 866.

"The appliance which I show you (Fig. 866) is constructed as follows: Caps of gold and platinum alloy, of about 26 to 28 U. S. standard gauge, are struck up to fit over and down the sides of the

natural teeth selected for the piers, fitting closely. If all the supporting teeth stand perpendicularly and parallel with each other, thus creating no 'undercut' (so to say), the sides of the caps may encircle the teeth as far as possible (*not*, however, impinging upon the gum-line), and be simply slit (in two or more places on each tooth) perpendicularly, so as to spring apart and allow of sliding the whole over the natural convexities of the teeth, the sides coming together again when in place and thus holding the whole apparatus firmly. But should the teeth be tipped or leaning, and not parallel, the sides of the caps must then extend over only such parts as can be closely fitted and yet be sufficiently perpendicular and parallel to allow of removal and replacing of the appliance. Of such a character is the case now shown you, there being only one place on the six caps where a *slit* is of value; the sides of the caps being so fitted as to hold partly by their own elasticity, and partly by that of the whole apparatus. Such a case, of course, will most severely try the capabilities of any artificial denture; and not the least merit of the present piece is its triumph over, and perfect and *practical* adaptation to, the obstacles of an exceptionally difficult case.

"The caps, when struck up, will not cling to the teeth when in place; nor should they, for they must be capable of easy removal during succeeding processes. But when the piece is ready for final insertion, the sides of the caps must be *sprung inward* sufficiently to hold to their supports with firmness.

"The caps being now made, it is in order to determine the length of 'bite' needed. Place the caps in position in the mouth, and build wax on their grinding surfaces to a proper length and contour, both side and grinding. Invest, remove wax, and flow into its place eighteen-carat gold. Shape the grinding surfaces, by trial in an articulator or the mouth, to the proper occlusion. Next, take an impression with the caps in place, pour the model, select and back plain plate-teeth, and wax them in place. Invest the whole, remove the wax from the backs of the teeth, and fit in the spaces between the caps, bands, or bars of irido-platinum alloy (or gold, as circumstances may determine), being careful that the bars fit *accurately* to the *backings* of the porcelain teeth and to the *caps* at each end. In fitting the bars to the caps, select such points of attachment as will not interfere with the *spring* of the slit sides of the caps. If necessary, let the bars avoid the *sides* of the caps, and reach, by curving, to the *tops* or grinding surfaces. Should you desire to arrange the porcelain teeth irregularly, you need not hesitate to do so. Set them just as you would for rubber or celluloid, and then, simply taking a 'finger impression' of their backs with modeling composition or wax, when

invested as above stated, and making dies, you can readily 'strike up' your bars to fit the irregular positions of the backings. But should this be difficult on account of great irregularity or stiffness of bars, then construct the bars of two or three thicknesses of metal, each struck up separately, and then 'sweated' into one. Next, solder the bars to the backed teeth, but *not* to the caps, as yet. The reason is that *perfect* adaptation of the bars to the caps is absolutely necessary to the success of the piece. Therefore, now place the caps in place in the mouth, and wax the bars with their attached teeth in the spaces between them; filling, grinding, and adjusting until all is exactly as required. Then (and not until then) take an impression of the whole in place, the apparatus coming away with the plaster. Pour the impression with plaster and pumice, sand or asbestos (sand is best), carefully remove the impression plaster, invest outside the model with its sustained apparatus, and then solder the caps and bars together. In doing this as little solder as possible should be used, to prevent warping of the whole. The bars should have a broad, firm hold on the caps; but the contour of their union should be made on the bars *before* they are united to the caps, and *not* by flowing on a body of gold while uniting the bars and caps sufficient to attain the desired hold and shape of union. On the contrary, the bars should be properly shaped at their ends, and carefully fitted to the surfaces to which they will be attached, when a small amount of solder flowed into the joint will make a perfect union and give all the strength possible. This is *not* plumbing work. All that now remains to do is to spring or bend slightly inward, as before directed, the sides of the caps so that they may grasp their supporting teeth firmly, yet not so much as to create difficulty in removal or insertion; then finish and polish. Burnishing is generally objectionable, since it gives, in some lights, a *black shine* to the piece, adding greatly to the prominence of the appliance as a part of the view whenever the wearer opens his mouth.

"Should it be desired to produce the best possible results with the piece, the interstices between the artificial teeth and any other crevices to be found may be filled with gold or amalgam,—I prefer the former; or vulcanite may be packed in such places (which may be, if necessary, cut out to proper dimensions by burring), and finished up smoothly. The piece shown you contains no less than *seventeen* gold fillings, which signifies that no debris, or even moisture, has any foothold of concealment about it, and that it is, therefore, as clean in itself as is possible for any artificial denture to be. This, you will say, is rather expensive work. Very true. The whole method is expensive in both money and labor. But I am quite consoled for this

fact by the thought that it will not, therefore, be likely to do much harm to the public, since the 'cheap-jacks' and 'incompetents' will probably let it alone.

"In the piece shown there are six caps, three on a side. There are five incisor teeth placed between the canines, two of which are capped with gold to break up the uniformity of porcelain in front, as contrasted with the uniformity of gold behind, and thus help to evade artificiality of appearance. Between the molar caps and the double caps for canine and bicuspid, the connecting bar is horizontally placed, dipping downward to parallel the gum line, as well as to evade an encroaching molar above. When necessary, an artificial tooth or teeth can be ground and soldered to these bars. Generally, however, the connecting-bars should be perpendicularly placed, to insure resisting strength in the line of the attacking force."

Dr. R. Walter Starr, in the same journal, describes the following case of removable bridge-denture:—

"The case of Mr. W. presented difficulties of an unusual character, as may be seen by inspecting the illustration, Fig. 867, which renders detailed description unnecessary.

"It will be observed that the molars and the left second bicuspid overhang to a degree that would make the taking of an accurate impression by ordinary methods well-nigh impossible. After a careful study of the case it was decided that two separate pieces of removable bridge-work should be attempted, and, as an essential preliminary step, the overhanging sides of the molars and bicuspids were ground with engine corundum wheels and points until those sides were made much less inclined, when plaster impressions were taken, first of one-half, and then of the other half, of the jaw. Gold cap-crowns were closely fitted over the molars, left second bicuspid, right first bicuspid, and cuspid stump. Gold crowns were made to telescope over all the caps, which were then, by means of oxyphosphate

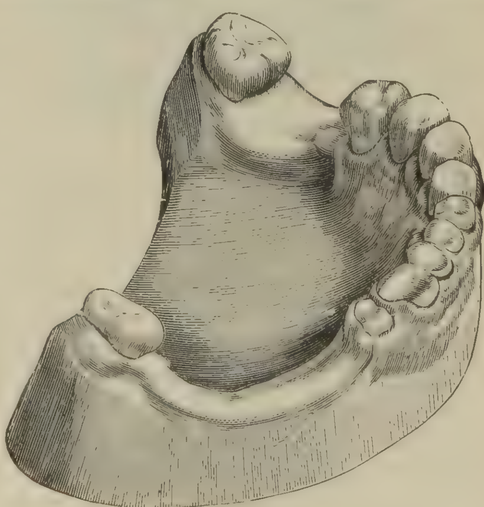


FIG. 867.

cement, fixed firmly on the teeth. Suitable plate-teeth were selected, fitted, backed, and hard-waxed in place between the telescoping crowns. After hardening the wax with cold water from a tooth-syringe, the pieces were carefully removed, invested and soldered. The two completed bridges were easily replaced on or removed from the supporting capped teeth, and their appearance when detached is correctly shown by the illustration, Fig. 868, which also shows the capped teeth and stumps. This figure likewise shows the results of the novel method employed in crowning the incisors. Gold collars were fitted tight on the necks of the incisor stumps, and the new-style porcelain caps adjusted in the collars, and set in the oxyphosphate cement which had been packed into the collars; thus at the same time fastening the collars on the stumps and the caps in the collars, as shown completed in Figs. 868 and 869.

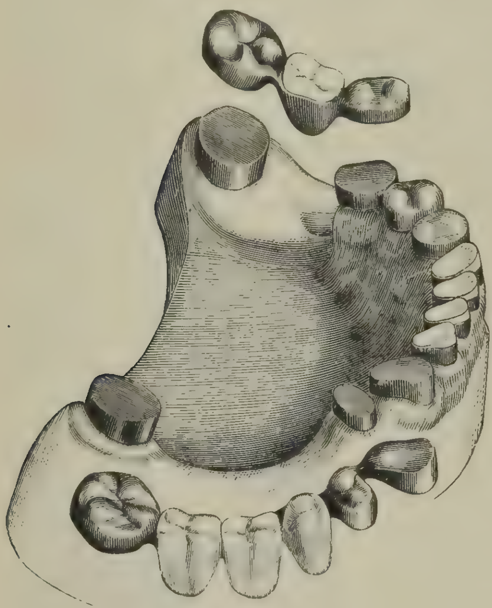


FIG. 868.

"Fig. 869 illustrates the finished crowns and bridges, which latter were secured in position by placing a small piece of gutta-percha in each of the telescoping cap-crowns, which were then warmed and carefully pressed in place—the gutta-percha filling only the spaces between the flat tops of the caps of the natural teeth and cusped caps of the bridges.

"Whenever for repair, or for any other purpose, it shall become desirable to remove one of the bridges, that may readily be done by applying a hot instrument or hot air to the caps, to soften the gutta-percha sufficiently to permit the telescoping bridge to be taken off.

"A full upper vulcanite denture was made to replace the old one, which, by improper occlusion, had thrown the full force of mastication on the anterior teeth of the lower jaw, and produced the destructive action that resulted in the deplorable loss of tooth substance shown in Fig. 867.

"The prosthetic devices thus briefly described have so far proved perfectly satisfactory to both patient and dentist. The obvious difficulties of the case, and the somewhat novel means employed in supplying useful and secure dental substitutes, seem to justify the writer in bringing the case to the attention of the profession."

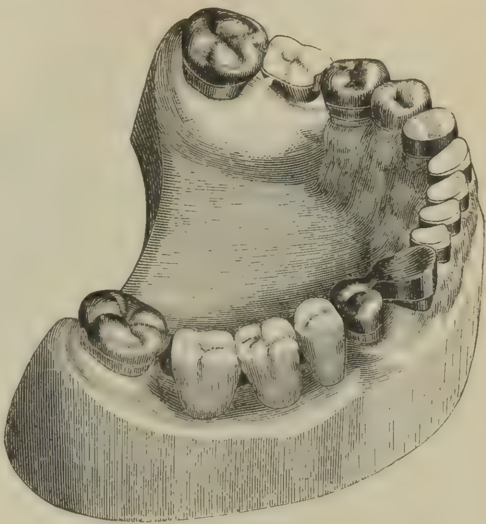


FIG. 869.

A bridge of this form can also be made removable by cementing it on the natural crowns or roots with gutta-percha, and by still further securing it by screws entering the body of the crowns or roots through the gold forming the occluding or grinding surface portion.

Dr. H. C. Register has devised the following method, which, in the event of a porcelain crown being broken, possesses the advantage of allowing the place to be filled by a new crown without disturbing the main appliance. The following concise description of this method is by Dr. Dexter:—

"Taking a typical case (Fig. 870), a rim or saddle of gold, platinum, or iridinized platinum is struck to fit the spaces between the teeth A and B. To this are attached bars, X, Fig. 872, to enter the fillings at Z, Z (Fig. 871). Posts or pivots (D, Fig. 872) are soldered upon this saddle where the artificial teeth are to be placed, their free ends being threaded to carry the nut E. Hollow crowns, countersunk for the nut at G, and having the necks ground to reach over the saddle and press upon the gum, are fitted over each post. Amalgam is used to fill in the space between the post and the tooth-wall, as in a Bonwill setting, and the crowns are drawn to place and held with the nut. The saddle is fixed in its place in the mouth, before the crowns are finally attached, by filling into the cavities Z the bars X X."

Dr. J. L. Williams suggests the following methods for the single crown and for "bridge-work," which he describes as follows:—

"It consists essentially of three parts: a square pin of platinum

and iridium which enters the enlarged pulp-canal, a cap of gold, and the porcelain face, which is the ordinary plate tooth.

"This crown is made in the following manner: After the end of

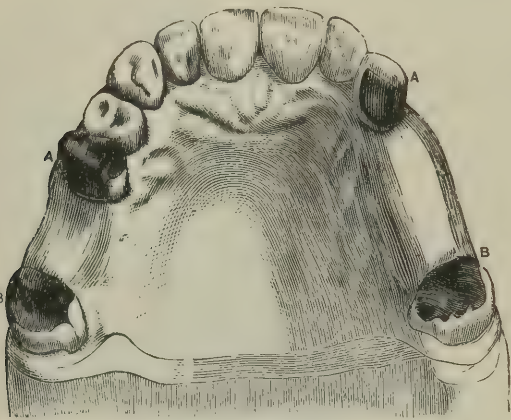


FIG. 870.

the root is made perfectly smooth with corundum wheels and properly shaped scalers, a gold ferrule or band is fitted around it. If it is desirable that this band should be entirely concealed, the labial surface of the root should be beveled a little above the margin of the

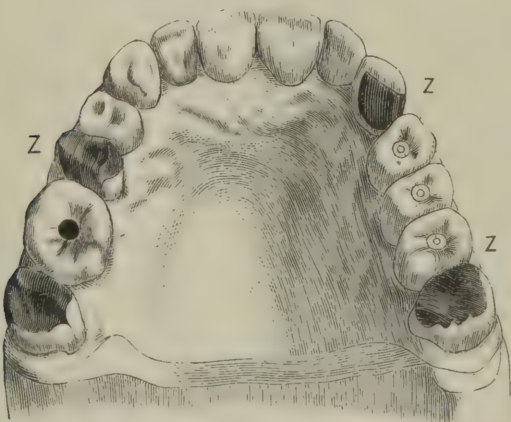


FIG. 871.

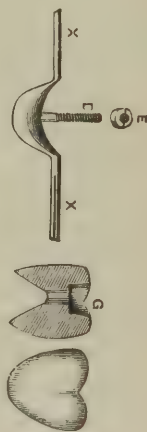


FIG. 872.

gum, and after the band has been soldered it may be placed in position, and the line of contour of the margin of the gum marked upon the front of the band. The proper bevel can then be cut and the

edges squared upon a corundum wheel, leaving the lingual portion of the band a little longer than the front. Pure gold, rolled to No. 34 of the standard gauge (American), is used for soldering upon the beveled surfaces, thus making a closed cap for the end of the root. A suitable tooth is now selected and backed with pure platinum or pure gold. The cervical end of the tooth is then ground to the proper position on the front bevel of the cap, all of the fitting being done while the cap is in position on the root.

FIG. 873.

"After the fitting is completed the cap is removed and the tooth attached by strong resin wax and again placed in position while the wax is warm. Any slight change in position which is necessary can then be easily made. The tooth and cap are now removed together, invested, and united at the back by solder. It is well to use a solder for the cap with a higher melting point than that used for the backing, as it obviates the danger of unsoldering the band when the backing is flowed on. After finishing and polishing the work, the end of the root is made perfectly dry, a sufficient quantity of oxyphosphate cement, mixed somewhat thinner than for filling purposes, is placed in the enlarged pulp canal and also in the cap. The crown is then carried to place with firm, steady pressure, held a few minutes until the cement is sufficiently hard to prevent displacement. The surplus cement which has oozed out around the band should be carefully removed, and the work is then completed."

Dr. Williams's method can be applied to "bridge-work," as the following Figs. 874, 875, and 876 will show.

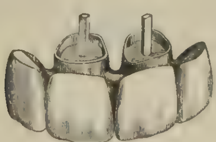


FIG. 874.

FIG. 875.

In this method, special crowns, Figs. 877 and 878, for molars and bicuspids, with porcelain faces, are made, which are backed with gold or platinum and the tips ground squarely off. Zinc pattern dies are made from the grinding surfaces of molars and bicuspids,

to be used for swaging from pure gold a tip or cap for the protection of the porcelain face. The concave surface of these tips is filled by melting coin gold into them, and this surface is then ground smooth and fitted to the squared surface of the porcelain face and waxed into position. Triangular pieces of platinum are then cut of the proper size to fit the sides of the tooth, waxed in position,

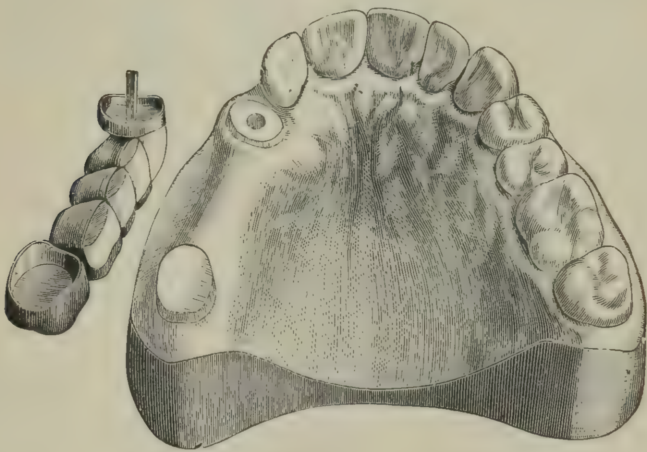


FIG. 876.

FIG. 877.

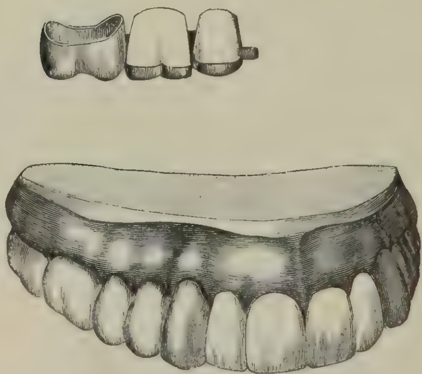


FIG. 878.

and the whole invested, leaving the back open, which is filled with coin gold.

Dr. Williams also describes other forms of bridge-denture, in one of which there are no supporting roots, and in the other the sections are united by bands of gold.*

* *Dental Cosmos*, December, 1885.

"Figs. 879 and 880 illustrate a method of inserting extensive pieces of bridge-work in cases where there are no natural teeth or roots for supporting one end of the bridge. The work from which these drawings were made was constructed by Dr. H. A. Parr. By this method bridges may be inserted in cases where all of the teeth on one side of the mouth have been lost, or where all the teeth anterior to the molars on both sides are wanting. Crowns are first fitted to the teeth which remain. These crowns being in position, an impression is taken. From this a cast is

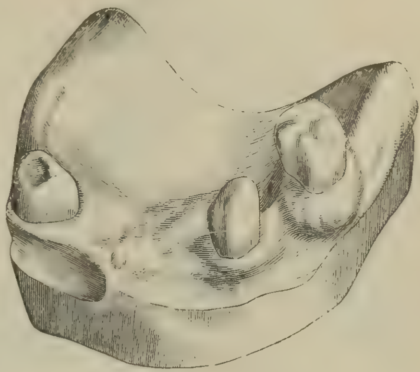


FIG. 879.

obtained with the crowns in their proper positions. A second impression is also taken of that portion of the mouth where there is no natural support for the bridge. From this impression metallic dies and counter-dies are obtained, from which is 'struck' a small gold plate about three-fourths of an inch in length and width, the size of the plate varying according to position and other conditions. After this little plate or 'saddle' has been perfectly fitted, it is waxed in the

FIG. 880.

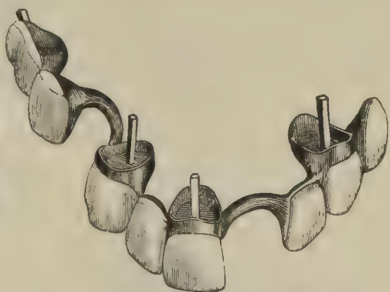


FIG. 881.

proper position on the model, with the crowns. The intervening teeth are now placed in position, and the work invested and soldered. To provide for the possibility of shrinkage or absorption at the point where the plate or saddle rests, it is suggested that it be not soldered to the bridge, but attached by means of an adjustable screw.

"Fig. 881 illustrates another device for obviating the necessity for

removing the crowns of natural teeth in preparing the mouth for bridge-work. Crowns are fitted in the mouth to the points of attachment in the usual manner. An impression is taken, bringing the crowns away in their proper positions. From this the cast or model is obtained. Heavy bands of half-round gold or platinum bars are now fitted around the necks of the natural teeth, on their lingual surfaces. These bands, being waxed in position, serve to connect the different parts of the bridge, uniting them in one piece without the loss of any of the natural crowns. I have found this a highly satisfactory method of inserting extensive pieces of the work. Fig. 882 shows the mouth as presented, for which the piece shown in Fig. 881 was constructed. Fig. 883 shows the piece in position.

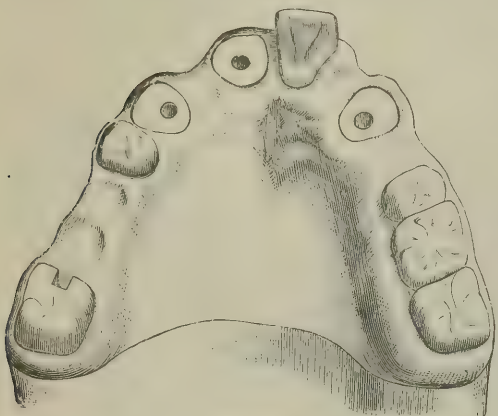


FIG 882.

FIG. 883.

"Fig. 884 illustrates a case which is a type of a class of frequent occurrence. Alternate molars and bicuspids in the upper and lower jaws are lost until the occlusion is somewhat changed, and the force of mastication is gradually brought upon the front teeth. Rapid wearing of these teeth results. These cases are among the most difficult that the operator is called upon to treat by the ordinary methods. In the case herewith illustrated, the lower bicuspids with a molar on one side were in good condition, but the loss of the upper bicuspids and molars made them useless. As usually happens, the upper incisors had suffered most. The lower incisors were restored by capping them with cohesive foil. The bridge shown at Fig. 885 was constructed for the right side of the upper jaw, while the teeth on the left side were restored by contour work, as shown at Fig. 886.

"The superiority of the condition of this patient's mouth, which resulted from this work, over anything which could have been accomplished by plate work, is almost inconceivable to one not familiar with these methods.

"The only annoyance which bridge-work is likely to cause patient or operator is the occasional breaking of a porcelain, an accident of

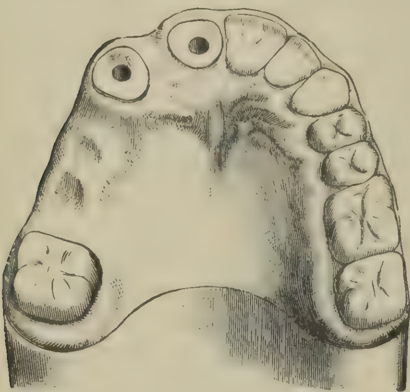


FIG. 884.

FIG. 885.

not frequent occurrence. While the replacing of a broken porcelain has never been a matter of extreme difficulty, yet I have always regarded the methods hitherto employed as more or less imperfect and uncertain in their results. This led me to devise a method of replacing broken porcelains which leaves the work fully as strong as before; a method which makes the operation a very simple one, requiring less

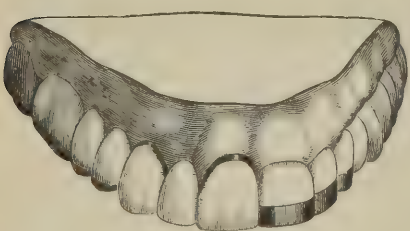


FIG. 886.

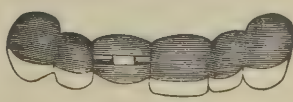


FIG. 887.

than an hour for its performance; and after the porcelain has been replaced, an expert would not discover any traces of an accident. After removing all traces of the broken porcelain, the projecting pins are cut off, and two holes drilled through the backing in the exact position occupied by the pins. The narrow space of metal now in-

tervening between these two holes is cut out with a fissure-bur. This leaves a groove which should not be wider than the diameter of the pins. The length of this groove should now be increased on the lingual surface, but not on the front. The object of this is to give a dove-tail shape to the groove, which is easily effected by the use of the same fissure-bur above referred to. The lingual appearance of this groove when properly shaped is shown in Fig. 887. The proper tooth is selected, the pin passed through this hole and bent outward into the dove-tail groove. It now remains but to fill the space between the pins with any form of cohesive gold (I use crystal gold), and with corundum, Arkansas, and rubber points in the engine the surface is finished and polished. The wedge-shaped filling of crystal gold acts as a keystone between the pins, and makes a most perfect method of repair."

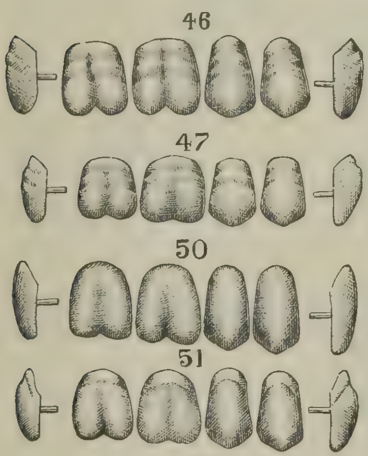


FIG. 888.

Porcelain veneers or facings for bridge-work are represented by Fig. 888.

These facings of molar and bicuspid forms have two long platinum pins (cross-wise) for attachment. They are specially designed for use in bridge-work operations. The long pins afford facility of repair when a tooth has been broken in use. Incisor facings of the same character are also employed.

Dr. H. W. Howe recommends the following flux that is exceedingly useful in bridge-work and is prepared as follows. Put in a cup :—

Boracic acid,	1 oz.
Ammonia,	½ oz.
Carbonate of ammonia,	½ dwt.
Bicarbonate of soda,	2 dwt.
Water,	4 ozs.

Boil until the fumes of ammonia are no longer given off. Coat the bridge or other work all over the gold with the flux. Heat it over a spirit-lamp to dry it on. Give it another coat, if needed, leaving no part exposed. Then scrape off where it is desired that the solder shall flow, and it will go nowhere else. The work will come out of the heating as bright as when it went in, and the solder will be smooth. The polished surfaces will not be corroded or blackened.

Dr. A. S. Condit has devised a combination of plate- and bridge-work, and describes his method as follows:—*

"How well do bridge-workmen know the difficulties incurred in preparing a case for a piece of bridge-work when the teeth on each side of the case converge or diverge! My object in devising the new method was to avoid the above mentioned difficulties. It is sometimes almost necessary to expose the pulp, to make the sides parallel. By the new method it is only necessary to dress the tooth until the band or crown can be nicely adjusted, the same as would be done to nicely cap the tooth for its preservation.

"The attachment tubes or sockets are placed upon the bands or crowns parallel to each other, regardless of the position the teeth may occupy in the arch.

"Fig. 889 represents a case where all the teeth posterior to the cuspid on the right side of a lower jaw are lost, a case which could not be retained by a clasp, and the only method known to the profession is to couple the teeth on both sides with a plate, permitting all the pressure of mastication to come on the gums and alveolar process, causing continued absorption and the usual tilting of one side while biting upon the opposite side. In following the new method a band or crown is first made for the tooth adjacent to the space to be filled, then a tube or socket is made of gold or any suitable metal and soldered to the band or crown on the side next to the space on a line parallel to the lingual side of the tooth. The length of the tube is governed by the amount of space between the tooth so attached and the tooth in the opposite jaw. The longer the tube the better, yet when two attachments can be made the tube can be very short, for the solidity of the work depends almost entirely upon the lock-pin. By this method no undue pressure is placed upon the gums, as the resistance in mastication is partly taken up by the tooth or teeth to which attachment is made. The tube or socket referred to, which, as previously mentioned, is soldered to the band or crown, has placed on the lower end an annular flange, making the opening at the lower end of the tube a trifle smaller than at the upper end. To this tube is fitted what is termed the cap and shield. The shield part is also a tube just large enough to fit over the one fastened to the band or crown and encircle it except at the side which is soldered. The cap covers the upper end of the large tube or shield and has a thread-hole through the center into which is screwed the lock-pin. The lower end of the lock-pin is split and surrounded by an annular groove which corresponds with flange in tube upon band or crown, so that when lock-pin passes into the tube it is compressed

* *Ohio Dental Journal.*

by the flange until it reaches the groove upon the pin when the spreading out of the pin locks it firmly in place and it cannot be detached

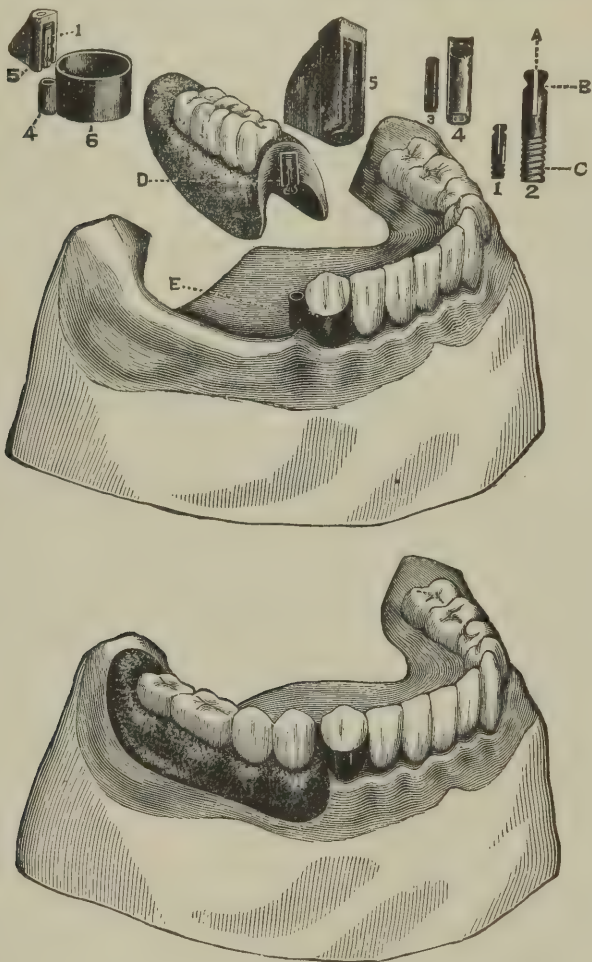


FIG. 889.

In upper portion of above illustration is represented the device in sections, viz:

1 represents the exact size of split pin.

2, the same magnified, of which A represents the split.

B, the annular groove, and C the screw.

3, the exact size of the tube or socket.

4, a magnified view of same.

5, shows the different parts of device put together.

6, illustrates a band with tube 4 attached.

D, represents the device placed in the work, and E the tube or band ready for adjustment.

except by a straight up or down pull. The cap and shield also has a projecting ear, the purpose of which is to firmly hold it to the plate.

"Fig. 890 represents a case attached to central incisor and second molar on the right side of lower jaw. This is a case which would be considered impracticable for any other kind of work and right here

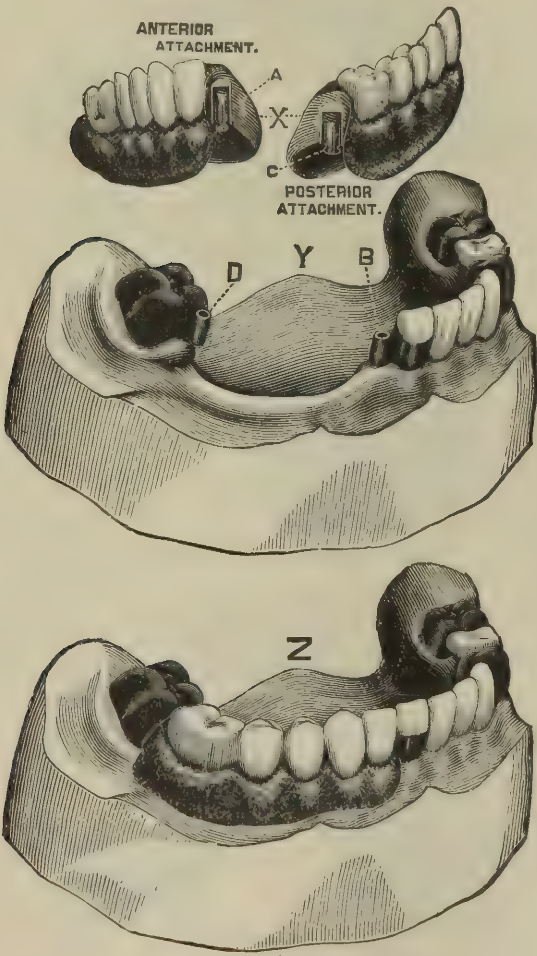
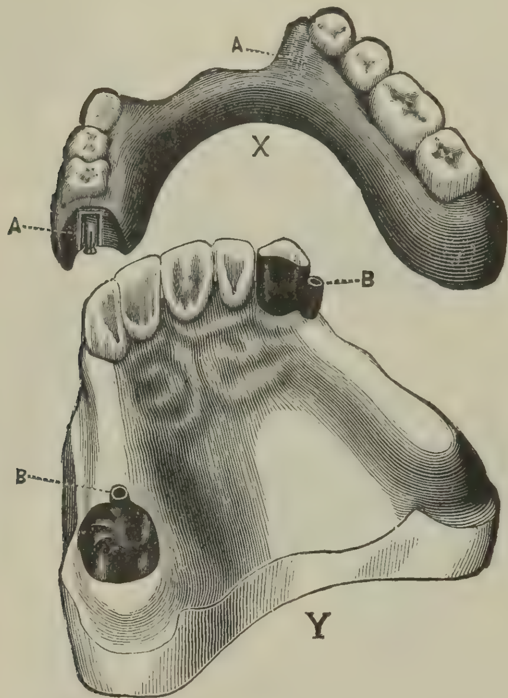


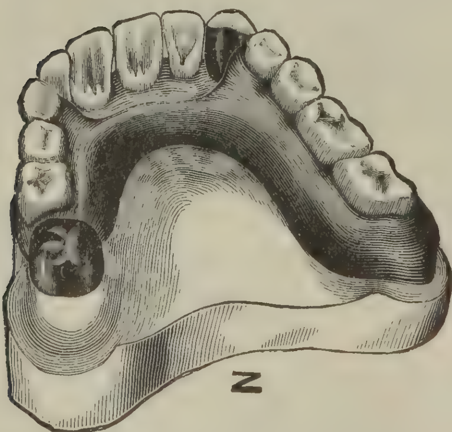
FIG. 890.

In Figs. 890 to 894, X represents the work ready for adjustment. Y casts of the mouth with bands and crowns in position and tubes in proper place for the insertion of the work. Z the work in position on the cast. A represents the device as placed in the work. B the tube placed on band. C the split pin in position in the device, and D the tube as placed on crown.

it might be said that it was the difficulties presented by this case of making anything satisfactory or permanent by any former method,

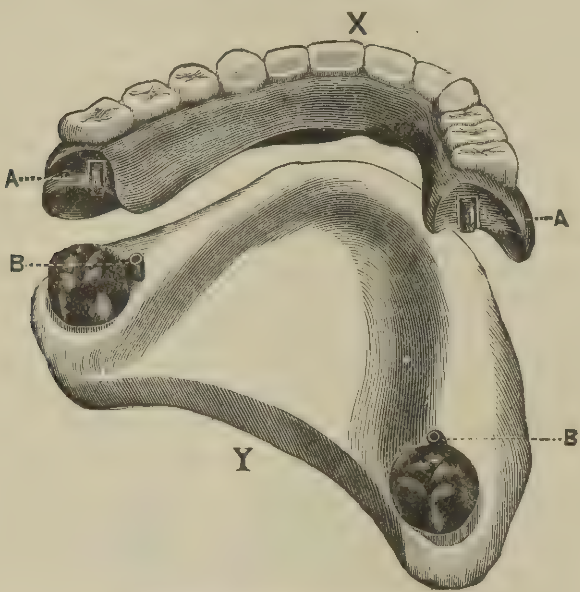


Showing mode of attachment.

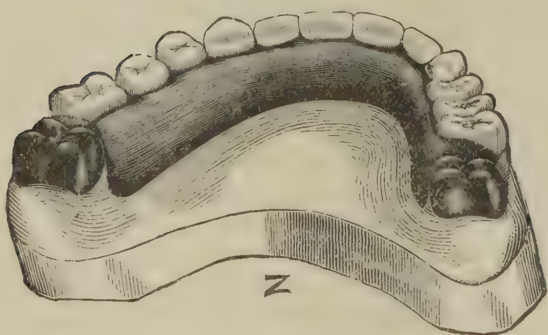


Showing bridge-plate in position.
FIGS. 891, 892.

that caused the devising of "The New Method." On the left side of the jaw was a piece of bridge-work which forbade any attachment of plate to that side and it was certainly not advisable to use the incisor as one of the piers for a piece of bridge-work, for it would soon be



Showing mode of attachment.



Showing plate in position.

FIGS. 893, 894.

moved from position and lose its efficiency if suspended from the gum; nor was there any more encouragement of retaining the plate by clasping one or both teeth. It was quite a puzzle to know just what was the best thing to do. It was certain if satisfaction was attained some-

thing new must be adopted and the solving of the problem brought to life 'The New Method.'

"Figs. 891, 892 represent the upper jaw of the case above cited. With molars and bicuspids gone on the left side, the cuspids and bicuspids gone on the right, in this case we find it necessary to connect the teeth on both sides, that the strain occasioned by the weight on cuspid may be relieved somewhat by the molar. No one rule can be applicable in all cases, but the general principles are so familiar that they need no description and with slight modifications they may apply in most cases. In this case an attachment was made to cuspid and molar, connecting the two by a narrow strip of plate, thus avoiding the covering of the entire palate, and when the work was in place it was equally as strong for mastication as bridge-work could be.

"Figs. 893, 894 represent an upper case with only the second molars remaining. The attachments are sufficiently secured for comfort in masticating with but very little if any strain upon the natural teeth.

"One of the strong features of this method and one that cannot be attained by any other class of work in cases of absorption of the gums and alveolar process, which is not apt to occur as there is no undue pressure, is that the tube and lock-pin can be shortened and the plate brought as close to the gum as desired."

Dr. George Evans describes his method of forming hollow gold molar and bicuspid dummies for bridge-work, and also of making collar or ferrule crowns, in which no gold is exposed at the cervico-labial portion, as follows: * —

"Practical experience in bridge-work evidences the advantages of all-gold bicuspid and molar dummies in cases which properly admit of their use; but where they are long or large, the weight and expense, owing to the amount of gold required to fill them, are at times objections to their use. To overcome these objections and lessen the labor of construction, he had lately devised a method of making all-gold dummies hollow, as follows: Take a contour gold crown of suitable size, with a thick grinding-surface, or one which has been thickened with solder and the flux removed, and cut away the gold forming the palatal section of the collar to the form termed self-cleansing, or shape the neck of the crown to the exact contour of the portion of the gum the dummy is to rest on, and scrape a little from the surface of the model to cause pressure and insure closeness of fit. Melt a small quantity of solder with flux to a ball form. Fit a piece of platinum plate, about No. 32 gauge, over the aperture; place the ball of solder on the platinum within the gold cap (see Fig. 895).

* *Dental Cosmos.*

Hold cap and platinum in a Bunsen flame, and heat slowly until the solder melts and appears under the edge of the cap, then instantly remove from the flame, trim the platinum, and stone the edges. This gives you a hermetically inclosed dummy-tooth of gold, from the interior of which the air has been exhausted by the heat. The dummy can then be placed in its position on the bridge and soldered in the usual manner. Fig. 896 gives the palatal aspect of a bridge the dummies of which were constructed in the manner described. The bicuspid dummy is given a self-cleansing form, and the molar is shaped to rest on the gum.

"The advantage of a collar or ferrule on crowns for the front teeth as affording additional security of attachment and insuring against all possibility of longitudinal fracture of the root, is generally accepted.

"The objectionable features of collar crowns are the exposure of the collar at the cervico-labial section, which is difficult to avoid, and the irritation its presence there is apt to cause the peridental membranes, which it is more liable to do at this point than at the other sides of the root. The collar, to be invisible, has to be fitted well under the gum-margin. This requires extensive removal of the periphery of

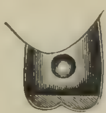


FIG. 895.

FIG. 896.

the cervico-labial section of the end of the root, rendering adaptation of the collar at this point an operation few practitioners succeed in accomplishing perfectly. An examination of collar crowns in the mouths of patients frequently results in showing a condition, as regards construction and adaptation, such as is shown in Fig. 897, at either of the points A or B, or both. At A, the edge of the collar, owing to the inward slant of the root, protrudes slightly, and at B the porcelain is projected beyond the line of the collar for position or to hide the metal. Either or both in time produce and maintain an unclean condition, worse than a deep-seated line of cervical decay in a natural crown, causing irritation and gradual absorption of the adjacent investing-membranes.

"The form of crown about to be presented is not new in principle, neither is it offered as a universal substitute for the ordinary collar crown, but as embodying features which are advantageous, and without some of those found objectionable in the ordinarily used collar crowns. The method will greatly simplify and facilitate the operation, and it is one which can be accomplished by those of only ordinary skill.

"Take, for example, the right superior incisor illustrated in Fig. 898. A shows the line of trimmed root; B, point at cervico-labial section which may be removed if it is desirable to have only the porcelain front cover that part. In Fig. 899 an enlarged outline of the surface of the prepared end of the root is presented, A being the

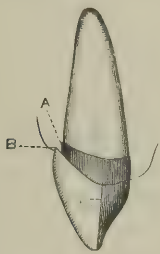


FIG. 897.

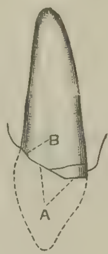


FIG. 898.

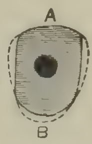


FIG. 899.

labial and B the palatal side. The dotted line is intended to indicate the original form. The shaping is done in the usual manner with discs and trimmers. It will be seen that the line of the labial portion is left intact.

"The root-canal is next enlarged with an Ottolengui root-canal reamer (see Fig. 900).

"The size and condition of the root and the judgment of the operator should determine the number or size of reamer to be used and the depth to which the canal should be reamed. To the reamed canal is fitted a prepared iridio-platinum post, as illustrated in Fig. 901, cor-


FIG. 900.


1 2 3
FIG. 901.

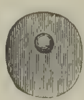


FIG. 902.


FIG. 903.


FIG. 904.

responding in size by number to the reamer used. These posts have a screw-thread cut on the sides, tapering downward to the point, so that they can be screwed just where wanted and soldered in an instant. Next take a prepared disc of platinum plate, having a perforated concave depression as seen in Fig. 902. This depression fits in the orifice of the root canal. If necessary, the orifice may be slightly enlarged with a round-headed bur. This disc of platinum plate, which is about No. 35 gauge, is made by stamping with a punch or

dic. In the depression in the disc, as shown in section in Fig. 903, pure gold with a little flux is melted, and in the center of this gold a hole is punched through the disc. The post when fitted to the canal is grasped at the line of the orifice of the canal with small pliers, the post removed, and without moving the position of the pliers it is screwed into the disc up to the points of the pliers, thus giving the post its position in the disc. The sides of the disc are bent on account of the approximal teeth, as shown in Fig. 904, and the relative positions of the post and disc on the root are determined.

"The disc should fit in the orifice of the canal when the post is in position. By twisting the post in the disc, change of position is instantly effected. Both post and disc are next removed, and the post secured in position in the disc by being held in a Bunsen flame, and heated to a point that fuses the pure gold in the depression. No flux is necessary, as sufficient remains from the first fusing of the gold. The post with the disc is next inserted on the root, the platinum pressed with a large flat plugger, and malleted so that the line of the edge of the end of the root will be impressed upon it. The platinum is next removed, and slit at the two points between the palatal and approximal sides shown at A and B, Fig. 905, and guided by the mark of the end of the root on the platinum the approximal portions are bent over with small-pointed pliers to embrace the sides of the root. The post and cap are then placed on the root, and the side flaps, with the aid of foot-shaped condensers and burnishers, are closely fitted. The palatal flap is next brought down to position. Frequent removals and annealings are necessary during the process, which should include finally trimming the edge of the platinum, smoothing with a corundum point, and then annealing and all-around burnishing of the cap to the root.

"At the cervico-labial section the porcelain can rest on the platinum, or the platinum can be trimmed so that the front edge of the porcelain may be fitted against the root, covering it (see Fig. 905). The projecting end of the post should also be removed, leaving it a little flush at the palatal side. The porcelain front, which should be a cross-pin plate tooth, is ground and closely fitted to the surface of the root or metal, as may be, at the cervico-labial section under the edge of the gum, but a properly shaped space opening toward the palatal side is left between it and the surface of the cap. To so shape the porcelain simplifies the fitting of the cervical section. The space between the cap and the porcelain is also easier filled in the soldering. To the porcelain front at the part B (Fig. 906) a piece of very thin platinum foil is shaped, the porcelain heated, the part veneered with a mere film of gum-shellac, and by pressure with a napkin or cotton the

platinum foil is attached thereto. The rest of the porcelain is then backed with thin platinum plate (about No. 35 gauge). The platinum is left slightly extending over the incisor edge, and the porcelain front is waxed in position on the cap.

"Fig. 907 shows the crown waxed up ready for investment. Wax in full amount must be extended over the collar to its edge, in the seams, and between the porcelain and the cap at every point solder is to flow. (Dr. Evans generally uses Parr's fluxed wax.) Fig. 908 shows the invested crown with the wax removed. In trimming the investment, the material must not be removed from over the collar lower than the line of the surface of the cap, or in such a manner that the platinum turn-over edges are exposed to the direct force of the flame. If the collar is not exposed, the solder will flow over the outer surface of the platinum just where it is wanted and where wax has been applied, and all the parts will become united.

"The investment must be slightly raised at one end, and heated up at its base with the full flame of a gas blowpipe thrown in the direc-

FIG. 905.

FIG. 906.

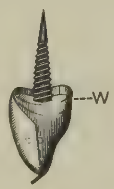


FIG. 907.

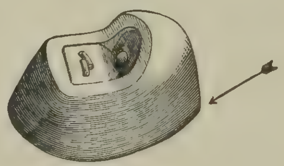


FIG. 908.

tion indicated by the arrow in Fig. 908. Heat thus applied will cause the solder to flow downward and fill the interstices in all parts of the investment as though it were an ingot. The best way is to apply a little solder at a time until the deep parts are filled. The flame is then withdrawn for an instant, and with a small pointed flame and more solder the backing can be contoured. As platinum forms the cap and backing, the soldering can be conducted without fear of accidentally fusing those parts.

"The form of crown described, as well as the ordinary collar crown, he usually cements in the following manner: Having the root and crown ready, he warms the crown and applies a thin coating of chloro-gutta-percha to the post. The chloroform, instantly evaporating, leaves a film of heated gutta-percha. Immediately the crown is adjusted to the root and removed. This shapes the gutta percha on the post. The crown is then allowed to cool, and is cemented on as though no gutta-percha was used on post. A crown so cemented can be removed at any time by repeated applications of the thick part

of a heated root-canal drier to the metallic portion of the crown, which communicates the heat to the post. In a short time the sheath of gutta-percha around the post is softened, and the crown can usually be removed without difficulty. He also attaches ordinary bridge-work in this way, having abandoned the use of methods classed as 'detachable,' which only allow the bridge to be removed by the dentist.

"Porcelain can be used in the construction of the crown described instead of gold solder. In such a case, the porcelain front should be attached to the end of the post. This can be done by flattening the end of the post and riveting the pins, or by soldering them.

"Fig. 909 represents a removable pin crown. It consists of a crown having a threaded socket, I, to which is fitted a correspondingly threaded silver pin, II, which admits of freedom in grinding and fitting the crown to the root without the interference of the stationary pin.

"Another crown, known as the Downie Crown, is designed to obtain a perfect adaptation to the root by means of a platinum band or cap, which not only prevents the splitting of the root, but protects the joint from decay and the washing out of the cement, and materially

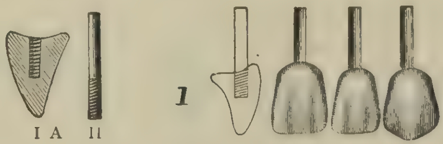


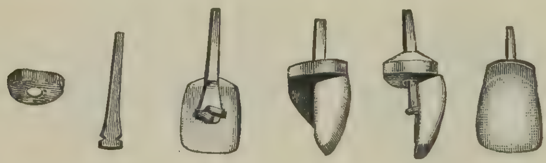
FIG. 909.

strengthens the attachment of the crown ; the anterior portion of the band is covered with porcelain of the same color as the facing, so there is no metal showing whatever, and no necessity of cutting the root off far above the gingival margin and lacerating the gums ; it is made with the teeth used for other work, so that no special tooth is required ; the backing is fused on to the facing, making a perfect union, so we do not need any metal to protect the point to keep the facing from being broken off ; the laborious work of grinding away the back of the tooth, and the always unsatisfactory guesswork in setting the facing, which are necessary in some other porcelain processes, are entirely obviated.

"Fig. 910 represents the Downie Crown, the directions for constructing it by the use of the Downie Porcelain Crown Furnace, represented by Fig. 912, being given as follows :—

"Dress up the root even with the gums, and prepare it in the usual manner for crowning. Take measure with small wire, cut the wire on the opposite side from the twist, and straighten it out. Take a strip of platinum, about 30 gauge, of sufficient width for the band, lay

the wire on the platinum and mark the length. Cut $\frac{1}{32}$ of an inch longer than the mark, bevel both ends, lap to the mark, and solder together with pure gold. In this case, as in all others in porcelain work, the soldering should be done with as small an amount of gold as possible, and then the joint dressed off so that there is no gold left showing. Fit the band to the root, letting it extend nicely under the free margin of the gums. If the band is now nearly even with the root, grind it off flush. If it extends much beyond the surface of the root, it should be marked and removed to be clipped off, then replaced and ground perfectly even. It is again removed, and a piece of platinum fitted and soldered over the top, using pure gold as a solder. The overhanging edge of the top is now clipped off and filled up, and the sharp edge of the cap dressed off, also the edge of the band. The cap is now completed as shown in Fig. 910, 1, except that it has now to be placed in position on the root and a hole punched through the top to correspond with the canal, for the insertion of the post. The material most suitable for making the post is square iridio-platinum wire, but it may be made of platinum wire,



1 2 3 4 5 6

FIG. 910.

either round, square, or three-cornered. The wire is flattened out on one end so that it is broader than the space between the pins of tooth selected, and a notch filed in each side, corresponding with pins, so that it will slip in between them. After measuring root canal to see the length of pin required, the wire is cut off and the end tapered, making a finished post as shown in Fig. 910, 2. It is now placed between the pins, which are bent over as shown in Fig. 910, 3.

"The ordinary plate teeth are used in making these crowns, as will be seen by the cuts, but they may also be made with the plain teeth used for vulcanite work, and sometimes to good advantage. When this kind of a tooth is used, however, the post should be soldered between the pins with pure gold, as the back is not flat like the back of a plate tooth, and it will not be held firmly enough to the post by simply bending the pins over. The tooth is now fitted to the proper position by bending the post if necessary, or grinding the base to let it up if too long; this should be done with the cap in place. The position of the tooth on the cap should now be noted and both re-

moved and well dried. Placing them in their relative position as near as can be judged while out of the mouth, back the tooth up to the cap with hard, sticky wax prepared especially for the purpose. While the wax is still soft, it is set on in position in the mouth to get the articulation exact. The wax is hardened by dropping on to it a little cold water with the mouth syringe, and the crown can then be removed with the cap, without shifting the relative position of cap and tooth. This part of the operation may also be done as follows: After a tooth is fitted and both it and the cap removed and dried, place a napkin in the mouth and dry the root and adjacent parts. Place cap in position, and taking a piece of sticky wax previously prepared, about the size of a pea, warm it and place it directly on top of the cap; then stick post of tooth through the wax, and press it up to position. Whichever of these methods is employed to set the tooth on with wax, it is necessary to see that the palatine side of the cap is down in its proper position before removing it, as the pressure brought to bear on the anterior side by pressing the tooth up to position will tend to tip off the posterior side, especially if the cap is shallow. The wax may now be chilled, and the case removed for investment. In removing, it is best to hook the cap off with a hoe-shaped excavator, instead of removing the tooth with the fingers and depending on the wax to draw off the cap. If the cap should be loose after the piece is removed, which will be the case if there has been any moisture on the cap when the wax was pressed on, take a wax spatula and melt the wax on the cap, and replace in the mouth to be certain the articulation is correct, and remove again. The case will now appear as in Fig. 910, 4. Remove from around the post, with small knife blade or other instrument, any wax which may have been drawn down into the canal while pressing the tooth into position.

"Mix up equal parts of silex and plaster, and fill the cap, building it up, crowning around the post. After the investment sets, boiling water is poured on the case to remove the wax. Fig. 910, 5, shows the silex and plaster in the cap and the wax boiled out. As will be seen, the investment is put in the cap for the purpose of retaining it in position on the post after the wax is removed. If desired, the tooth may be entirely invested and the cap soldered to the post, but this is not necessary unless it is to be used for the support of bridge teeth. The next step is to build on the porcelain body. This is in the form of a powder, and is mixed up with water and applied with a small camel's hair artist's pencil. A color should be selected several shades darker than the base of the tooth, as it requires a darker shade to cover the band and not appear lighter than the tooth, while it is sufficiently translucent so that the thin portion which overlaps the tooth will not

make it look perceptibly darker. It should be mixed as stiff as can be handled with the brush. The post is held with a pair of pliers while the body is applied with the brush, tapping the pliers with the brush handle to jar the body down into the crevices, and smooth off the surface. If it does not run down well between the tooth and cap, wet the brush slightly and apply a little more water, but always work it as dry as possible and still have the surface smooth down when the pliers are tapped with the brush handle. Build out well on the cap and around the front to conceal the band, but do not build down over the pins of the tooth the first time. The piece is now ready for the first fusing. In baking, the crown is placed in the tray of the furnace, which is made of platinum and has a hole through the posterior edge through which to place the post, the tooth being placed face up, resting on the back of the band as shown in Fig. 911. This prevents the piece being fused on to the tray, as the body is not built over the back of the band. The furnace should be heated up very slowly, so as not to check the tooth or throw off the porcelain body by drying it out too quickly. However careful the operator may be, there is always a slight amount of wax left on to the tooth around the pins, which on heating up will burn out, making the body black until it is all burned out. If the case is heated up too rapidly, this will sometimes separate the body from the tooth so that it will not fuse on, especially down near the pins, or it may throw the body off entirely. Great care should be taken, however, to remove all traces of wax before building in any body, and the greatest cleanliness should be observed through the whole process. The pins and post at the place of attachment are now filed or ground off so as not to interfere with the bite. If the bite is very close the back of the tooth may be ground away at the point of contact, so that it will not strike.

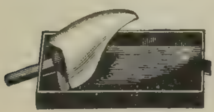


FIG. 911.

"During the first baking the body has shrunken considerably, but it is now built up again, shaped as desired, and fused, making a finished crown, as seen in Fig. 910, 6. In the case of bicuspids and molars, especially when the bite is short, it is often better to build them up entirely with the body, not using any tooth or facing.

"In making these crowns with the ordinary porcelain body, the facing will become etched, or rough and pitted, and on being handled will have black specks over its surface, thus marring its appearance. This is entirely overcome by using Downie's Porcelain Body, which fuses at a temperature so much below the fusing point of the enamel on the teeth that they come out of the furnace as smooth and perfect as they were before baking.

"Another valuable point gained in using this low-fusing body is that one can easily determine when it is sufficiently fused. The white heat required for the high fusing body makes it extremely difficult to see when it is properly glazed; but as this fuses at a red heat, the gloss on the piece can be watched closely, and when it is seen to shine it is done.

"The color of the teeth can also be matched to almost a certainty with our latest improved body. It may be fused just to a glaze, or considerably above, and still be the same color, as the coloring materials are not so fugitive as they are at the higher heats.

"It is the next thing to an impossibility to bake two pieces of the high fusing body at different times and have them come out the same shade; so there is positively no certainty whatever in matching colors with it. A slight difference in the fusing may bleach out the colors so as to ruin the case. Often when the darkest shades of yellow are used, the thin portion around the neck of the tooth in front will bleach out almost white in trying to get a good glaze. No troubles of this kind are encountered if the new low-fusing body is used. Although it was imperfect when put on the market, it has been improved until it has been brought to a remarkable degree of perfection."

The Downie Porcelain Gas Furnace (Fig. 912) will, it is claimed, fuse the Downie body in one and a half minutes, or even less time, and the following directions for using this furnace are given:—

"If properly set up and operated, the porcelain will be fused in the Crowning Furnace, in inlay work, in less than one minute, and crowns in from one and a half to two minutes. This is counting from the time the blast is turned on. Bridges or sections take a proportionately longer time, as they take longer to heat through.

"The body is handled with a brush adapted for that purpose, and mixed up with sufficient water so it can be built on where desired, care being taken not to get it so wet that it will run after it is built on. The crown or matrix, on to which the body is added, should be held with a pair of tweezers while the body is being built on, and the tweezers should be tapped with the brush handle to settle the body down and bring the water to the surface.

"The fresh body should be built the shape desired, and well smoothed over, as it keeps its shape pretty well and will show rough places after firing if care is not taken to smooth down by jarring while wet.

"The tray is then filled with silex and work set upon it in such a manner that the face of the work does not come in contact with the silex, as it would be fused on and destroy the appearance of the piece.

The tray is then put into the muffle, the furnace lighted and very gradually heated up to drive off the water, and if there is a veneer or block in to heat it up gradually and not crack it. This takes but a short time, however, from a half minute for inlays or small crowns, to a

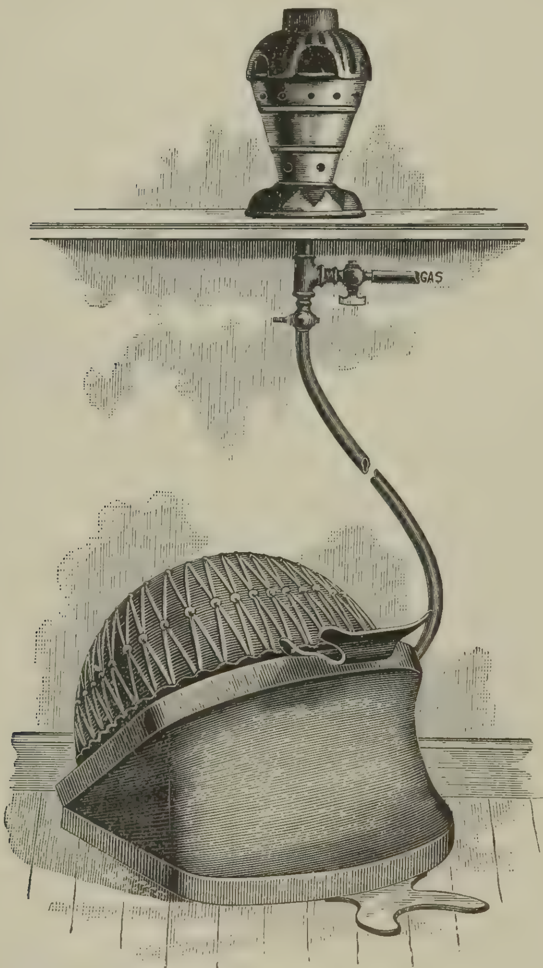


FIG. 912.

minute or minute and a half for large crowns or blocks. Then run the furnace to its full capacity until work is fused. The body should not be baked until it is thoroughly glazed the first time, but merely biscuited, or baked until it is well fused together. Leave in the muffle until it is no longer red, then remove and set in tempering oven, and

let it remain until well cooled down. Add more body to give the required contour and bake until well glazed, letting it cool off gradually.

"In making the Downie Crown, however, do not put any silex in the tray, but stick the pin of the crown through a hole in the back end of the tray, as shown in Fig. 911 on page 800, letting it rest on the pin and the band resting on the bottom of the tray.

"Care should be taken not to let any body or any fusible material get on to the interior of the muffle, as it will fuse the tray to the muffle and injure it in removing the tray. Should such a thing happen, put some silex on the bottom of the muffle.

"Care should also be taken to prevent the contact of any metal with the platinum muffle, as it is likely to make a hole after heating up."

A larger furnace of the same style is used for porcelain bridge-work, gum sections, etc.

Porcelain Bridge-Work.—This style of bridge-work has no joints to retain the secretions, and the gold of other forms of this work may be dispensed with in all places except where it is necessary to make an attachment to a gold cap; and with this exception the natural appearance can be almost perfectly restored. "No gold caps or cutting edges are required to protect the bridge teeth, for precisely the same reason that they are not needed in the crown-work. The crown already described is used as a support for these bridges, the only difference in its construction being that when intended for bridge-work, after setting it up in wax it is invested and the cap and pins soldered. This allows the crown to be set in position without the porcelain backing, and an impression to be taken with modeling compound. A model is run, the bridge teeth are waxed in, and the case invested. After removing the wax a bar of iridioplatinum is fitted from the posts of the supporting teeth across under the pins of the bridge teeth and soldered in position. The case may then be removed from the investment and the porcelain backing added and fused on; when it is necessary to use a gold cap for the support of a bridge, it is made of an alloy of gold and platinum (22 kt. gold); this admits of being soldered with pure gold, is quite hard, so that its wearing qualities are excellent, and goes through the heat of the furnace without oxidation. The bar is soldered to the cap, the porcelain added and fused, and the case handled in every respect as when porcelain crowns are used as supports."

Porcelain Inlaying.—One of the best methods for making them is to burnish platinum foil over and into the cavity, thus forming a matrix, into which the porcelain is built and fused. Body may be added and fused two or three times until the required contour is obtained. The platinum is then peeled off and retaining points or

grooves cut into the porcelain with the edge of a diamond disc; also undercuts made in the cavity, when the piece is ready for cementing on. The mistake is often made of taking too small a piece of foil with which to make the matrix. This should be large enough to be held easily in position with the thumb and finger of the left hand, while it is being burnished into the cavity with the right. This overlapping foil, by which the matrix is handled, is left on during the process of baking. There are two principal points wherein lie the secret of obtaining a good fit with an inlay: First, in making the walls of the cavity beveled outward for a little way from the margin, so that when the platinum is removed the plug will fit tightly on the margin as it bevels out, and will set in the thickness of the platinum removed, thus taking up the space occupied by it, and making a perfect fit at the margin; second, in only partially filling the matrix with body the first time it is baked, then replacing in the cavity and burnishing down the edge again; this corrects any springing of the matrix. For labial cavities, where there is no force to be exerted which will tend to loosen the filling, they may be set with Hill's Stopping, using a warm instrument handle to press them into place. This is perhaps more reliable as to lasting qualities than any cement which we have at the present day.

The Jacket Crown.—"This is a platinum cap with a porcelain facing, and is in certain cases very valuable; its use is indicated for undeveloped teeth, usually called rice or peg teeth. These may be built out and the normal appearance fully obtained. It is also of use in cases of badly decayed teeth where the pulp has receded considerably and is in a healthy condition; it is of no use for decayed teeth of normal size if the nerve has not receded and they set in their proper position in the arch, because they must be ground so near to the pulp in order to get the facing on without its being too prominent that the death of that organ is almost sure to result. There is no good reason why they should ever be used in any case where the pulp is not alive.

"To construct this crown, make a deep band or ferrule of platinum to fit the tooth, which has previously been ground slightly tapering on its sides and lingual surface, and flat (receding considerably) on the labial surface. The inner portion of the band, which stands up from the tooth, is clipped off and a flat piece soldered on to make the sloping lingual surface (supposing the crown to be an incisor or cuspid), and the anterior portion of the band ground very thin, except around the gum margin. This thin anterior portion is malleted down against the tooth, using a large foot plugger, and folding down the upper corners when necessary. A tooth is selected, either a flat back or a plain tooth for rubber work; it is ground away flat at the back, tapering down to

as thin an edge as possible at the base; after grinding until it will set in the proper position, the cap is removed and the facing stuck on with a little porcelain body. The piece is then set on a tray in which is a little ground silex to keep it from shifting around while in the furnace. It should be very carefully heated up, in order that the facing may not be thrown off. When cool, more porcelain is added around the edges to securely attach the facing, and, after fusing, the crown is ready to be cemented in place. All these operations in porcelain are made infinitely more practical by the use of the low-fusing porcelain body, which enables us to bake crowns without etching the face of the tooth, to fuse on to a bridge which is soldered to a gold cap, and to match the colors almost perfectly."

Dr. C. H. Land has devised what he calls "metallic enamel coatings and sections," which he describes as follows:—*

"The accompanying engravings, Figs. 913 and 914, are taken from

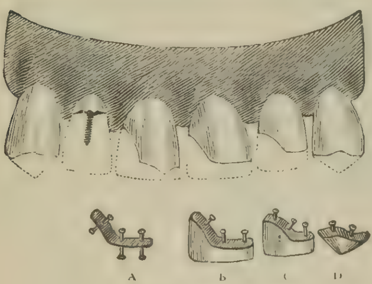


FIG. 913.

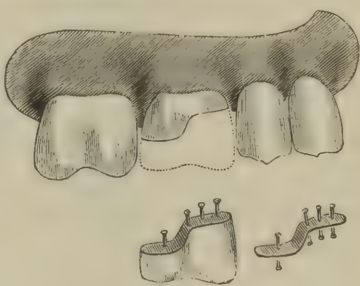


FIG. 914.

practical cases that have at this date been in use for one year. In the case represented by Fig. 913, the patient was about sixty years of age. The right lateral incisor was prepared with a Howe post, shown in its relative position. The five remaining teeth, after the cavities were prepared, contained tooth substance as represented by the dark surfaces, the white representing the lost portion of each tooth, restored with sections of porcelain made to imitate the exact color and contour of the original tooth substance. The cavities are prepared as for gold filling, when a thin piece of annealed platinum plate, No. 35 standard gauge, is placed over the tooth, and by means of burnishers made to take a perfect impression of the outer rim of the cavity, after which platinum pins are attached, as shown at A. The object of the pins is to serve as a fastening, both for the porcelain paste or body and as retainers to hold the completed section in the cavity of the tooth. The

* *Independent Practitioner.*

porcelain paste or body is built upon the platinum disc and made to imitate the lost portion of the tooth. It is then baked in a gas furnace, requiring but twenty minutes for the first biscuit and fifteen for the second, and when finished appears as shown at B, ready to be cemented with oxyphosphate. C and D are modifications for the other teeth, and Fig. 914 illustrates porcelain facings for molars.

"The especial feature of this system is the large amount of tooth substance preserved above the gum, there being no necessity for telescoping the root so far below as to sever the tissues. This mode of practice also dispenses with the long operations and protracted use of the rubber dam; it almost entirely obviates the use of amalgam, and saves the necessity for large gold fillings; there is no malleting, no long and tedious operation either for the patient or dentist, while at the same time teeth are perfectly restored, both in appearance and usefulness.

"There is another advantage in the use of the enamel coatings which is not, in my opinion, a trivial matter. When large metallic fillings are inserted, the constant thermal changes consequent upon their alternate heating and cooling must exercise an unfavorable influence upon the tissues about the tooth. Even if the pulp be dead and the root be filled, there will be a checking and fracture of the tooth in time from the continually varying changes of temperature. An inflammation of the membranes will also be likely to occur from the same cause, and thus the tooth will in time be lost, from the mere influence of the presence of a large mass of metal.

"It is also a fact that large gold fillings cannot be inserted without so much malleting that the strength of the tooth is gone, and frail walls are cracked beyond the possibility of repair. These dangers are all obviated by the use of the porcelain facings, while teeth so restored are much more natural in feeling and more grateful to the touch of the tongue than any metallic filling can be."

Dr. Land describes his metallic enamel sections as follows:—

"By reference to Fig. 915, Nos. 2, 7, 10, 12, and 15, there will be seen characteristic conditions of decay suitable for this class of work. 2 and 7 are the prepared cavities on anterior sides of molars. The manner of procedure is to burnish a thin piece of annealed platinum plate into the cavity. This takes a perfect impression of its outlines. The surplus edges are trimmed off and platinum pins attached, using pure gold leaf for solder. (See 3 and 4.) The pins serve as a fastening, both to secure the completed section in place and as retainers for the porcelain body. 5 and 8 illustrate the completed sections, showing the contour of the original shape of the lost portion of the natural tooth. Nos. 1 and 6 are prepared sections cemented in place.

"Having secured the prepared sections as shown in 3 and 4, porcelain paste or body is built upon them and carved so as to imitate

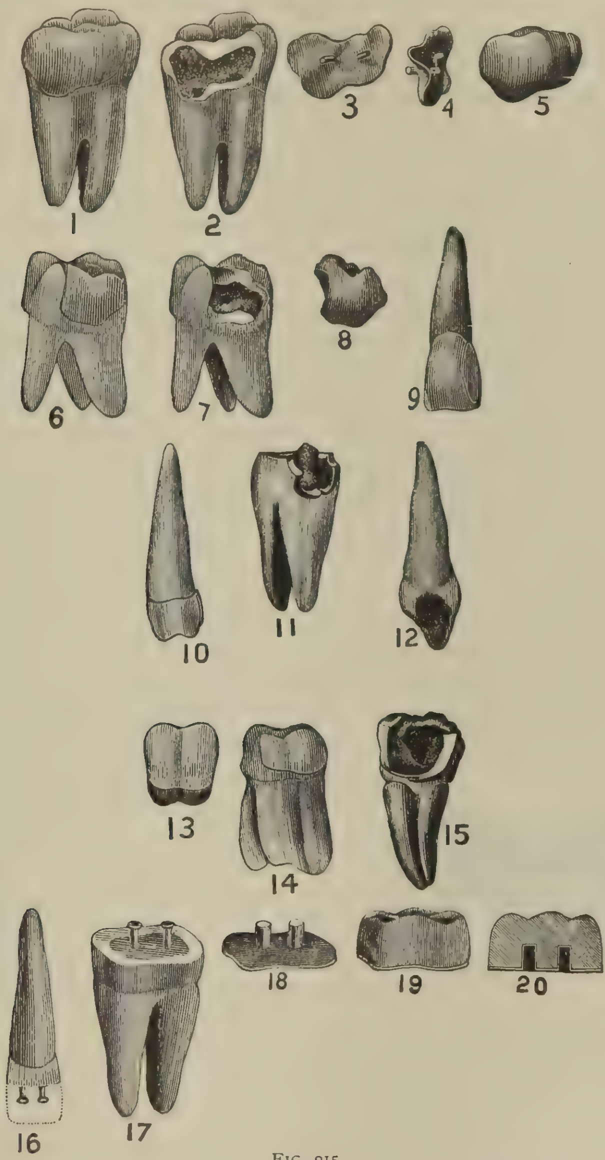


FIG. 915.

the original contour of the lost portion of the tooth, as shown in 5 and 8. They are then placed on a bed of silex and fused in a gas

furnace. This requires twenty minutes for the first biscuit and fifteen for the second. When completed, they will be a reproduction in porcelain of the lost parts of the natural organs, resembling nature perfectly, both in color and shape. They are then cemented in the cavity, either with gutta-percha filling or oxyphosphate cement. When the anterior side of a molar or bicuspid is decayed, as shown in 11 and 15, the enamel front or veneer, 13, is added to the porcelain body, and when completed it will appear as shown in 14. This veneer serves as a ready and efficient means of securing the proper shape and contour of each class of teeth. To those who are not familiar with the use of a gas furnace this class of work may seem difficult, but a little experience with the modern appliances now within the reach of every dentist makes the operation a comparatively simple and easy one. 17, 18, 19, and 20 are a modification. 17 represents a tooth filled with gold, having two pins attached. 18 is a platinum disc, with tubes adjusted to correspond to the position of the pins in 17. Porcelain body is built about the tubes, and when fused in the furnace the whole will form a porcelain crown, as shown in 19. 20 illustrates the relative position of the tubes, which are designed to form countersinks for the pins in 17. When cemented in place, it makes a very durable and beautiful piece of work. 16 is an incisor constructed in a similar manner. From this will be seen the great advantage of being able to have the porcelain in a plastic state, as it enables the dentist to perfectly adapt the form of each peculiar case with the utmost precision, and this could not be so admirably done with manufactured crowns.

"I wish to call especial attention to the large amount of tooth-substance preserved. In nearly all the modern systems of crown-work there seems to be too much good tooth-material cut away, and I think a careful investigation will demonstrate this new process to be far superior, making it possible to save the greater portion of the crown, it not being necessary to cut beneath the gum. In nearly every case, sufficient tooth-substance can be retained to preserve the pulp alive, and when the teeth are devitalized the major portions of the crown can be left intact, serving for retaining purposes and making it unnecessary, in the majority of cases, to resort to screws or posts. 16 illustrates a section of porcelain adjusted to a central incisor, which, when carefully done, makes a very acceptable piece of work. Although the joint may sometimes be conspicuous, it is not nearly as much so as a glaring piece of gold."

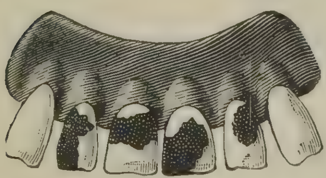


FIG. 916.

Fig. 916 represents a practical case for the insertion of the sections.

In concluding the subject of artificial crowns attached to natural roots and teeth, it remains only to briefly refer to the advantages and disadvantages of each method. As regards what is strictly pivot work, all methods are objectionable in which the exposed surface of the root is not protected from such agents as disintegrate tooth structure ; as regards the collar or ferrule crown, such work is objectionable where it causes irritation of the gum and periosteal tissues, or permits of the disintegration of the supporting roots or teeth, or is temporary in its nature, on account of the use of the plastic preparations in connection with it ; and lastly, all "bridge" or crown-work is objectionable where it cannot be kept perfectly clean and free from accumulations of fluid and other substances beneath it, and where it cannot be repaired in case of accident without breaking up the entire appliance. The effects of thermal changes on tooth tissues when brought directly in contact with large masses of metal, and the exceedingly frail nature of many of the porcelain crowns and facings required by some of the methods in use, should also be considered.

To grind the Logan tooth-crown, it has been suggested to take a hollow mandrel and, while in a hand-piece, heat the end and mount on it a corundum wheel, such as No. 00, being careful to make its outer face true and leave the hole in the end of the mandrel free for the pivot or post of the tooth-crown to enter. The neck of the Logan crown can then be ground without the risk of grinding the post or pivot, which enters the socket of the mandrel and is protected.

Solid gold cusps made of twenty-two carat gold and designed to be soldered to gold bands fitted to natural roots, and also for forming the masticating surfaces of porcelain crowns in bridge-work, can be obtained at the dental depots or be made by stamping thick gold plate with hard metal dies.

CHAPTER VI.

MANNER OF REFINING AND ALLOYING GOLD, AND CALCULATING ITS FINENESS.

GOLD is the best metal, and for general use the best material, that can be used for the attachment of artificial teeth. When used of proper fineness it resists the most acrid secretions of the mouth, and undergoes, during the long years of use, no change in its strength, form, or texture. Other metals and materials have a special utility, but none have so wide a range of usefulness, and none can take the place which this royal metal holds in dental prosthetics.

Gold in its pure state, free from alloy, is too soft and yielding to serve as a suitable support for artificial teeth; and, on the other hand, if it contains too much or an improper alloy, it will become tarnished by the secretions of the mouth, rendered too brittle for service, through those molecular changes which take place, with greater or less rapidity, if the plate is less than twenty carats fine. It is, therefore, of the utmost importance that the gold used in connection with artificial teeth should be of the proper fineness and possessed of the requisite malleability. To secure these qualities, it is necessary to know the kind and quantity of metal with which to alloy it before it is made into plate or other forms necessary for the purposes for which it is to be employed.

Gold clippings, filings, and scraps generally, if free from admixture with base metals, only require to be remelted if of a required fineness; but gold clippings, filings, and other scraps and parts of old gold plate or bridge-work, as found in the laboratory, are apt to become mixed with base metals, such as iron from the wearing of files, and occasionally small particles of lead, tin, zinc, or fragments containing solder If these are melted with and permitted to remain in the gold, they will destroy its ductility and render it unfit for use. Iron, less objectionable than the lead or tin, may be removed with a magnet before the gold is melted; but to free it perfectly from the others, it will sometimes be necessary to refine it by roasting, or to reduce it to pure gold by the humid process in the manner presently to be described. A two-thousandth part of tin or lead destroys the ductility of gold, and even exposure to the fumes of red-hot tin or lead renders it exceedingly hard and brittle.

The sweepings of a laboratory contain many impurities, both earthy and metallic, and they should be treated by either first washing thoroughly to remove the earthy matter, and the remaining metal refined separately. A better process, however, is to burn out the combustible substances, and then mix the residue with the following substances: to every eighth part of the sweepings add carbonate of potassa four parts, chlorid of sodium four parts, supertartrate of potassa one part, and nitrate of potassa half part; place in a crucible and subject the contents to the fire for some time after fusing occurs. As different affinities exist between metals, the selection of a reagent is governed by the nature of the alloy in the process of separating gold from foreign metals. Zinc or iron, or both of these metals, if present in gold in small quantities, may be separated by nitrate of potassa, as it yields oxygen, which has an affinity for such metals and converts them into oxids. Tin is more readily separated from gold by chlorid of mercury, for the reason that oxygen has a feeble affinity

for tin, whereas chlorin in the act of decomposition separates the tin from the gold very readily. When gold is contaminated with a number of these metals, which render it very coarse, the most powerful and efficient reagent is sulphuret of antimony, or resort may be had to the humid process and the alloy thereby reduced to pure gold. Antimony or bismuth, when mixed with gold, also renders gold hard and brittle. So marked is the influence of antimony in injuring one of the most valuable properties of gold, that its original name, *regulus* (little king), by which it is best known in commerce, was given in view of this controlling effect upon the king of metals. It is of the utmost importance to bear in mind the action of minute quantities of these four metals, so much used in the laboratory, upon gold, platina, and silver.

Platina, united with gold in certain proportions, has the effect of hardening the latter metal and making it very elastic, but does not materially affect its ductility. The affinity of the alloy for oxygen, however, is so great that it is readily acted on by nitric acid. The acids of the mouth will often make this alloy very brittle. But for this, the two metals, combined in the proportion of the fifteen parts of gold to one of platina, would form an exceedingly useful alloy for the construction of spiral springs. That a combination of two metals should be thus easily acted on by an agent incapable of acting on either when in a separate state may appear somewhat remarkable, but it is, nevertheless, true. We have in the effect of platina upon steel an analogous case. It makes the steel exceedingly hard and fine-grained; but although itself totally insensible to the action of oxygen, when alloyed in minute quantity with steel it causes this latter metal to oxidize with such readiness as to make it unfit for use.

Hence may be seen the fallacy of the idea, entertained by many, that because platina is a more indestructible metal than silver or copper it must necessarily make a purer plate. The properties of alloys are, in fact, so often and so widely different from those of their component metals that they can be ascertained only by experiment. Of the three metals, platina, silver, and copper, speculative theory might select the first and purest as the best alloy for gold; whereas, actual experience demonstrates that copper, itself the most injurious to the mouth, imparts most perfectly to gold, if kept within proper limits, those qualities which are required in a dental plate.

In view, then, of the importance of having gold which is to be placed in the mouth of the right quality, every dentist who has connected with his practice a mechanical laboratory should have the necessary fixtures for melting and working this metal into the various

forms required for dental purposes. The principal of these are, a small furnace, with crucibles and tongs, ingot-molds, an anvil and hammers, and a rolling mill; a plate gauge, draw plate, and bench vise; fluxing and refining chemicals, etc.

REFINING GOLD.

It is not our intention, in describing the manner of refining gold, to enter into a minute detail of the various methods employed for assaying or refining this metal, but to point out as briefly as possible the manner of separating it from the several metals with which it is most frequently combined in the dentist's laboratory. The two methods generally employed for separating gold from foreign metals are the "dry" and the "humid" processes, the former being a "roasting" process effected by the action on the alloy in a molten condition of either oxygen, chlorin, or sulphur; while the latter process (humid) reduces the alloy to pure gold by the solvent action of either nitric, sulphuric, and nitro-muriatic or hydrochloric acid.

The method usually employed by assayers for separating gold from silver is to roll the alloy out into very thin plates, and put it in nitric acid; this will dissolve most of the silver, and leave the gold behind in the form of brown plates, scales, or powder, which, after being thoroughly washed, is put into a crucible with borax and melted down into an ingot of pure gold. But this method will not succeed unless the quantity of silver be equal to two or three times that of the gold; for the nitric acid, which acts only upon the silver (and copper), cannot eat out all the alloy if its particles are too much surrounded with the particles of gold. From the old rule—one-fourth gold, three-fourths alloy—came the name given to this process, *quartation;* it is also known as the *nitric acid* process. It is well adapted to the purification of gold upon a large scale, and is the process used in the U. S. Mint. But it does not remove the platina so generally found in dentists' scrap; and it is not so well adapted for gold of 18-carat fineness and upward as the next process.

The nitro-muriatic or *aqua regia* process dissolves all the metals of the alloy, but immediately precipitates the silver. The gold is subsequently precipitated in a state of purity, thoroughly washed, dried, and melted down with borax. The process is, briefly, as follows: Melt the scrap to be refined; roll into a thin strip and curl it up into what is technically termed a *cornet;* place in a porcelain vessel and pour on the aqua regia, three or four ounces to the ounce of alloy, which must be mixed at the moment of using in the proportion of one part of pure nitric acid to two, two and a half, or three parts of hydrochloric acid; quicken the solution by heat from a spirit-lamp,

setting the vessel where the nitrous fumes can escape from the room; decant or filter the solution so as to separate the precipitated silver; evaporate the clear solution over a spirit-lamp, nearly to dryness, add hydrochloric acid, and evaporate a second time, so as to get rid of all nitric acid.

The concentrated orange-colored solution is the chlorid of gold together with the chlorid of platina and other metals, from which it must be separated by precipitation. Dilute largely with water, and add, little by little, a solution of the protosulphate of iron (green-vitriol), until the dark olive-brown precipitate, which instantly appears, ceases to form. Pour on this precipitate some sulphuric acid, to remove all traces of iron, and then wash several times with hot water, dry it, and melt with borax in a crucible.

Another method of refining is the *sulphuric acid* process, which it is unnecessary to describe further than to say that it resembles the *quartation* process. Gold is melted with five to seven times as much silver, granulated, and then boiled three or four hours in a platina or iron retort with sulphuric acid.

The late Prof. George Watts' process of refining gold by the "humid" or "wet" process, the solvent being nitro-muriatic or hydrochloric acid, which appears to give the most convenient results, is as follows:—*

"Let us then suppose that our gold alloy has become contaminated with platinum to such an extent that the color and elasticity of the plate are objectionable. The alloy should be dissolved in nitro-muriatic or hydrochloric acid, called *aqua regia*, the best proportions of which are three parts of hydrochloric to one of nitric acid. Four ounces of the aqua regia will be an abundance for an ounce of the alloy. If the acids be 'chemically pure,' four parts of the hydrochloric to one of the nitric produces still better results.

"By this process the metals are converted into chlorids; and as the chlorid of silver is insoluble, and has a greater specific gravity than the liquid, it is found as a grayish-white powder at the bottom of the vessel. The chlorids of the other metals, being soluble, remain in solution. By washing and pouring off, allowing the chlorid of silver time to settle to the bottom, the solution may be entirely separated from it. The object is now to precipitate the gold while the others remain in solution. This precipitation may be effected by any one of the several different agents, but we will mention only the protosulphate of iron.

"This salt is the common green copperas of the shops, and as it is

* *Dental Register.*

always cheap and readily obtained, we need look no further. It should be dissolved in clean rain-water, and the solution should be filtered, and allowed to settle until perfectly clear. Then it is to be added gradually to the gold solution as long as a precipitate is formed, and even longer, as an excess will the better insure the precipitation of all the gold. The gold thus precipitated is a brown powder, having none of the appearances of gold in its ordinary state. The solution should now be filtered, or the gold should be allowed to settle to the bottom, where it may be washed after pouring off the solution. It is better to filter than decant in this case, as, frequently, particles of the gold float on the surface, and would be lost in the washings by the latter process.

"Minute traces of iron may adhere to the gold thus precipitated. These can be removed by digesting the gold in dilute sulphuric acid, and, when the process is properly conducted thus far, the result is *pure gold*, which may be melted, under carbonate of potash, in a crucible lined with borax and reduced to the required carat."

By any of these processes, but most conveniently by the second, dental scrap may be refined to a purity sufficient for every practical purpose.

The Dry Process.—The form of furnace for melting gold depends much upon the kind of fuel. Charcoal, coke, and anthracite are the three kinds used; bituminous coal is inadmissible until converted into coke. The plumbing stores and stove factories now furnish so many convenient forms for the use of gas and many of these fuels that we shall not occupy time or space in their detailed description. A pipe six feet high will give to the ordinary "preserving furnace" a draft sufficient to melt gold with charcoal; coke gives a very intense heat, but needs a stronger draft; anthracite requires a powerful draft, but gives a more steady heat, needs less frequent renewal, and hence is better for long-continued heats.

As regards the shape and size of the furnace, the following points should be attended to: convenience of access to the crucible; sufficient depth and width to surround the crucible with a good body of fuel, without unnecessary waste of material.

Fletcher's small and convenient blast crucible furnaces, for melting gold by the use of gas and refined petroleum, are very serviceable in laboratory work.

Downie's crucible gas furnace (Fig. 917) is especially designed for melting metals, such as gold and silver, making alloys for amalgam, experimental work, etc. It is also very useful for brazing, soldering, heating up bridge cases or metal plates to solder, etc.

It has two removable rings of different widths, which set on above

the flaring base to carry the heat up around the crucible, the wide or narrow ring to be used, according to the size of the crucible, or both rings may be put on at the same time.

It also has a conical-shaped top which can be set on above the rings to confine the heat when it is desired to fuse any high-fusing substance.

For separating iron, copper, tin, lead, or zinc from gold, the following simple method may be adopted: After passing a magnet a number of times through the filings or fragments, to remove all traces of iron or steel, put the gold in a clean crucible, covered with another cruci-

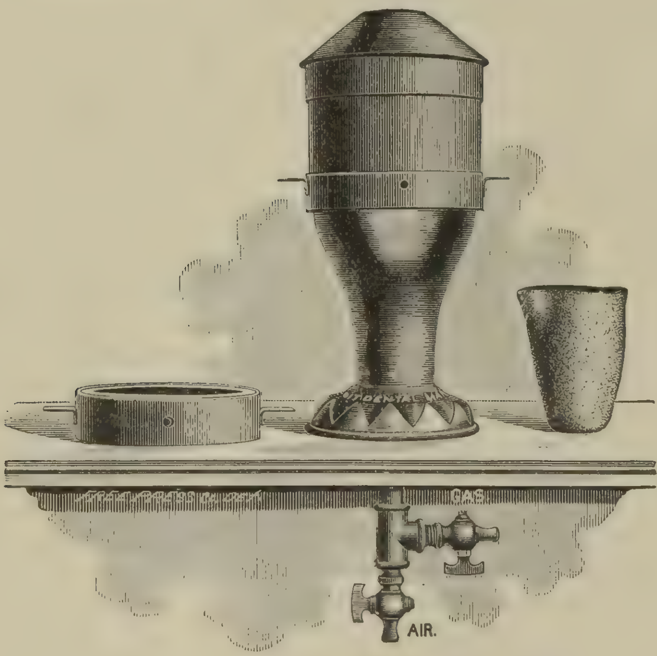


FIG. 917.

ble, having a small opening or hole through the top; lute the two together with clay; place them in a bed of charcoal in the furnace; ignite the coal gradually; afterward increase the combustion by means of a current of air from a pair of bellows, or by turning on the draft; after the gold has melted throw in, at intervals of about ten minutes, several small lumps of nitrate of potash (saltpeter) and sub-borate of soda (borax), and keep in a fused state for thirty or forty minutes; then remove the crucible and plunge in water to cool it; break it and separate the lump of gold from the dross; then put into

another crucible; melt with a little borax, and pour into an ingot-mold of the proper size, previously warmed and oiled. Bichlorid of mercury (corrosive sublimate) is sometimes used instead of or after nitre, for the purpose of dissipating the base metals, and often with more certain and better results, especially where the presence of any tin is suspected. If the gold cracks on being hammered or rolled, it should be melted again, and more nitre and borax thrown in; the inside of the crucible should also be well rubbed with borax before the metal is put in. It is sometimes necessary to repeat this process several times, and if the gold still continues brittle, a little muriate of ammonia (sal ammoniac) may be thrown into the crucible when the gold is in a fused state; after the vapor ceases to escape, the metal should be poured into an ingot-mold, warmed, and oiled as before directed. This last method of treatment will make the gold tough, and prevent it from cracking under the hammer or while being rolled, provided it is from time to time properly annealed during the process.

To separate tin and lead from gold, add corrosive sublimate ($HgCl_2$), and chlorid of zinc ($ZnCl_4$) or chlorid of lead ($PbCl_2$) are formed and with the mercury are volatilized. To separate silver from gold, from two to four times the weight of the gold of sulphid of antimony (Sb_2S_3) must be added in small quantities, the sulphid being decomposed by heat. The sulphids are formed by the sulphur uniting with the silver and other base metals, and the antimony unites with the gold, forming a leaden-colored alloy in the bottom of the crucible, while the sulphids remain on the surface. The antimony is separated from the gold by remelting the alloy and throwing upon the fused mass a current of air from a blowpipe. The oxid of antimony (Sb_2O_3) is thus formed, which is volatilized, and the process continued until fumes can no longer be driven off.

To remove iridium from gold, the latter is alloyed with three times its weight in silver, and the mass melted in a crucible, by which means the specific gravity is so greatly lowered that the infusible iridium subsides to the bottom of the crucible, when the gold and silver alloy can be poured off. As some of the gold still remains with the iridium, more silver must be melted with it and the process repeated as often as is necessary to remove all of the gold. The silver is then separated from the gold by the process already described. Platinum can only be removed from the gold by the humid or wet process.

By this method of refining gold, known as the *dry process*, or "refining by fire," sufficiently accurate results will be obtained for many of the practical purposes of prosthetic dentistry, since the

variation of an eighth or a quarter of a carat in the fineness of gold plate is not often a matter of much consequence. Comparing the two classes of refining processes—the *humid*, by acids, and the *dry*, by fire—the first is the most accurate, and the only way to remove platina or silver; but it is the most troublesome, and requires a familiarity with chemical details, which, unfortunately, many dentists are totally ignorant of. The second may remove the lead, tin, zinc, antimony, and bismuth, if in small quantity; and if continued for a sufficient length of time, with a free use of nitre, may remove a large proportion of copper. It can scarcely be depended upon if the object is to make an ingot of pure gold, but will answer admirably if the purpose is merely to lessen the alloy or remove certain impurities.

A very excellent method pursued by Dr. Elliott, of Montreal, is as follows: *—

"The following implements are necessary for this purpose: a small draft furnace; a quantity of fine hard-wood coal; a clean crucible, with a sheet-iron cover (a lump of charcoal is better); a light pair of crucible tongs; an ingot mold, made of soapstone; a little nitrate of potash, carbonate of potash, borax, and oil. The fireplace of the furnace should be about ten inches in diameter and eight or ten deep; this should be connected by means of a pipe with the chimney, so that a powerful draft may be made to pass through the coal. A blast-furnace is objectionable, for the reason that the bellows burns out the coal immediately under the crucible, and it is, therefore, constantly dropping down, which is not the case with the draft furnace; besides, the draft furnace produces a more even fire, a quality equally indispensable.

"In preparing for a heat, the furnace should be filled about half full of coal, and after it is well ignited it should be consolidated as much as practicable without choking the draft. The crucible containing the metal and a little borax may then be set on, and more coal placed around and over it, the door of the furnace closed, and the damper opened. It should remain in this way until the gold is perfectly fused. The coal may then be removed from over the crucible, and a bit of nitrate of potash dropped in, in quantity equal to the size of a pea to every ounce of gold, and the crucible immediately covered with a plate of iron. More coal may then be placed over and around the crucible, and the gold kept in a fused state at a high temperature, until the scoria ceases to pass off, which it will do in the course of five or six minutes. The ingot-mold, having been

* *American Journal of Dental Science.*

previously warmed, should be placed in a convenient position for pouring, and filled about half full of lamp oil. The cover should now be thrown off quickly, the crucible seized with the tongs, and at the same instant another small bit of nitrate of potash should be thrown into it, and the gold rapidly, but carefully, poured into the mold.

"The ingot always cools first at the edges, and shrinks away from the middle. On that account, the mold should be a little concave on the sides, so that the shrinking will not reduce the ingot thinner in the center than at the edges.

"Molds of the best form will sometimes produce ingots of irregular thickness. Such ingots should be brought to a uniform thickness under the hammer, using the common callipers as a gauge. If this be neglected, the plate will be found imperfect at those points where the ingot was thinnest. The plate should be annealed occasionally during the process of hammering and rolling, and should be reduced about one number in thickness each time it passes between the rolls. If any lead, tin, or zinc be mixed with the gold, the nitrate of potash must be used in much larger quantities, and, in that case, it is better to let the button cool in the bottom of the crucible. Then break the crucible and melt it in a clean one for pouring, using borax and nitrate of potash in very small quantities for the last melting.

"In case the subject of assay be in the form of filings or dust, a magnet should be passed through it, so as to remove every particle of iron, and then, instead of melting it with borax, it should be melted first with *carbonate* of potash, and afterward with *nitrate* of potash, in quantities proportioned to the necessities of the case, as before directed. Carbonate of potash is the only flux that will bring all the small particles of metal into one mass. Without it, a great portion of the gold will be found among the scoria, adhering to the sides of the crucible, in the form of small globules. This process of refining answers equally as well for silver as for gold."

ALLOYING GOLD.

Gold, when in an unalloyed or pure state, as before stated, is too soft to be used as a support for artificial teeth; consequently, it has been found necessary to combine with it some other metal, in order to harden it. Silver and copper are the alloys most frequently employed. Many dentists prefer the former, erroneously supposing that it does not increase the liability of gold to tarnish as much as the latter. But this opinion is sustained neither by facts nor experience. Gold, when alloyed with copper, unless reduced altogether too much for dental purposes, will resist the action of acids as effectually as when alloyed with silver, and the former renders it much harder than

the latter. Besides, it renders the gold susceptible of a higher and more beautiful finish. If, therefore, but one of these metals is used, copper may be regarded as preferable to silver.

The gold employed in prosthetic dentistry by most practitioners is altogether too impure for the purpose, it being not more than eighteen carats fine, and sometimes it is reduced even to fourteen. When not above these standards of fineness it is discolored by the buccal secretions, imparts a disagreeable taste to the mouth, and becomes brittle after it has been worn for a few years. The plate which is to serve as a basis for artificial teeth should never be reduced below twenty carats; and as that for the upper jaw does not require to be more than one-third or one-half as thick as that of the lower, the gold for the latter may be a little finer than that employed for the former, as it is necessary that it should be more malleable. The following standards of fineness may be regarded as the best that can be adopted for gold used in connection with artificial teeth: plate for the upper jaw, twenty carats; for the lower, twenty-one; and for clasps and wire for spiral springs, eighteen.

In reducing perfectly pure or twenty-four carat gold to these standards, first make an alloy of copper and silver, which may be either in the proportion of copper 4, silver 1, or copper 9, silver 1, according to the qualities required in the plate. The effects of the two metals are in strong contrast—copper giving hardness and elasticity, and deepening the color into a red; silver preserving the softness, and giving a greenish-white shade to the original yellow of the pure gold. Of these alloys take—to twenty-one grains of pure gold, three grains; to twenty grains of pure gold, four grains; and to eighteen grains of pure gold, six grains; to make, respectively, twenty one, twenty, and eighteen-carat gold. In the latter case, the alloy should be used containing most silver, as so large a percentage of copper makes the gold too hard and elastic, and gives it rather too red a color.

The gold should be first melted in a clean crucible, and as soon as it has become thoroughly fused, the silver and copper alloy may be thrown in, with two or three small lumps of borax. After keeping the whole in a melted state for some five or ten minutes, it should be quickly poured into an ingot-mold of the proper size, previously warmed and oiled. If the gold cracks during the process of hammering or rolling, it must be melted again and a few small pieces of borax with a little muriate of ammonia thrown in, and in five or ten minutes recast into an ingot.

When scraps and filings are to be converted into plate they should first be refined, afterward properly alloyed. This may also be neces-

sary with all gold the quality or fineness of which is not known; but with national coins having a known fixed standard this will not be necessary. When they are above these standards of fineness, the amount of alloy necessary to reduce them to the required fineness may be readily found by calculation. It is often unnecessary to change the fineness of either American (21.6 carat) or English (22 carat) coin; especially when the depth of the plate in upper cases, or the prominence of the ridge in lower, gives additional stiffness to the plate.

There are two principles upon which plates are alloyed. The first, and common one, is to add as much alloy as the gold will stand; the second is to add the least possible quantity. The first results in eighteen-carat gold, and uses mainly silver, lest the six grains of alloy should make it too brittle. The last results in twenty or twenty-two-carat gold, and uses chiefly or exclusively copper, since the least quantity of this gives the greatest stiffness.

The simple rule is to have the purest plate which the form of the mouth will permit. For shallow mouths, requiring increased stiffness, a twenty-carat plate may be used; but better practice still is to increase the rigidity by greater thickness, or sometimes by doubling some part of the plate.

In connection with the alloying of gold, it is proper to make some remarks upon the terms in which the fineness of alloys is expressed, and the means of ascertaining it.

Pure gold being taken as the starting-point, it may be expressed by unity (1), or by 24, or by 1000. In the first case, fineness is given in *fractions*. In the second case by parts called *carats*, which, for convenience, may be considered as equivalent to a grain; thus representing pure gold by 24 grains, or 1 dwt. In the third case, value is expressed in *decimals*, and is the most convenient system, although the second is the most customary with jewelers and dentists.

The following table, prepared by the late Prof. Austen, will show the relative value of these three systems in a few of the most usual forms of gold alloy:—

	FRACTIONS.	CARATS.	DECIMALS.
Pure gold, ...	1.	24.	1000.
English coin, ...	$\frac{11}{12}$	22.	916.6
American coin, ...	$\frac{9}{10}$	21.6	900.
Dentists' gold, best, ...	$\frac{5}{6}$	20.	833.3
" " good, ...	$\frac{4}{5}$	19.2	800.
Jewelers' gold, best, ...	$\frac{3}{4}$	18.	750.
" " good, ...	$\frac{5}{8}$	15.	625.
" " common, ...	$\frac{1}{2}$	12.	500.
Commonest solder, ...	$\frac{1}{3}$	8.	333.3

The table gives the amount of pure gold; subtracting which from the number at the head of each column will give the amount of alloy. For example: best jewelers' gold contains 18 carats of pure gold and 6 caráts of alloy; or three-fourths pure gold and one-fourth alloy; or 750 parts pure gold and 250 parts alloy.

To know how much alloy is required to reduce gold from one fineness to another, Prof. Austen gives the following rule: *Divide the lower carat* (c) *by the difference between the lower carat* (c) *and the higher* (C); *divide the weight* (W) *of the gold by this quotient* (c ÷ (C — c)), and it will give the amount of alloy (A) to be added. He also gives the following table of DIVISORS, which will be found convenient, as saving the necessity of much calculation:—

CARATS.	22.	21.	20.	19.	18.	16.	14.	12.
24.	11.	.7	.5	3.8	3.	2.	1.4	1.
22.		21.	10.	6.3	4.5	2.6	1.7	1.2
21.6		35.	12.5	7.3	5.	2.8	1.8	1.3
20.				19.	9.	4.	2.3	1.5
18.						8.	3.5	2.

The first vertical column represents the fineness *before* alloying; first horizontal column the fineness *after* alloying. Example: To reduce a double eagle (weighing 516 grains, 21.6 carats fine) to 20, 18, and 12-carat plate, divide the weight by 12½, 5, and 1⅓; this gives the amounts of alloy to be added—for the first, 41.3 grains; for the second, 103.2 grains; and for the third, 387 grains.

When it is required to know the fineness of the plate or solder made from known quantities of gold and alloy, *multiply the weight* (W) *of gold, before alloying, by its carat valuation* (C); *divide this product* (CW) *by the weight of the gold after alloying* (W + A); the quotient will be the carat value (c) of the alloyed gold.

This and the preceding rules may be also expressed by algebraic formula:—

$$(1) \qquad A = W \div \frac{c}{C - c}. \qquad\qquad (2) \qquad c = \frac{CW}{W + A}.$$

The fineness of any mixture of alloys of known value may be found by a simple arithmetical rule. Multiply each weight by its carat (pure gold being 24), divide the sum of the products by the sum of the weights, and the quotient will be the carat value of the mass.

The following formulas may be employed for manufacturing gold

plate from pure gold for dental purposes: Nos. 1, 2, and 3 for the base, and No. 4 for clasps:—

No. 1.

Gold Plate 18 Carats Fine.

18 dwts., ...	pure gold,
4 dwts., ...	pure copper,
2 dwts., ...	pure silver.

No. 2.

Gold Plate 20 Carats Fine.

20 dwts., ...	pure gold,
2 dwts., ...	pure copper,
2 dwts., ...	pure silver.

No. 3.

Gold Plate 21 Carats Fine.

21 dwts., ...	pure gold,
2 dwts., ...	pure copper,
1 dwt., ...	pure silver.

No. 4.

Gold Plate 20 Carats Fine.

20 dwts., ...	pure gold,
2 dwts., ...	pure copper,
1 dwt., ...	pure silver,
1 dwt., ...	platinum.

The following formulas may be employed for manufacturing gold plate from coin gold: No. 1 for the base and No 2 for clasps:—

No. 1.

Gold Plate 18 Carats Fine.

20 dwts., ...	coin gold,
2 dwts., ...	pure copper,
2 dwts., ...	pure silver.

No. 2.

Gold Plate 20 Carats Fine.

20 dwts., ...	coin gold,
8 grs., ...	pure copper,
10 grs., ...	pure silver,
20 grs., ...	platinum.

Gold plate 20 carats fine according to formulas No. 4 and No. 2 is suitable for clasps, backings, and irregular appliances where great strength and elasticity are required.

The following formula of Johnson Bros. gives an 18-carat gold plate:—

United States gold coin, ...	64½ dwt ($60)
Pure silver, ...	13 dwt.

CHAPTER VII.

INGOT MOLDS, ROLLING MILLS, SOLDER.

The gold, after being refined or alloyed, should be re-melted in a clean crucible, well rubbed on the inside with borax, and poured into an ingot mold (Figs. 917 A, 917 B) of proper length, width, and thickness.

Ingot molds may be of iron, soapstone, asbestos, charcoal, or car-

bon. The first is perhaps most convenient. The second gives, with the same gold, a tougher ingot; the asbestos ingot block, which may also be used for melting, is a perfect non-conductor, and is represented by Fig. 918; it is 2½ inches wide and ½ inch thick. With the charcoal ingot mold the greatest toughness of metal is obtained, so far as the nature of the ingot-mold can modify it. Pig-iron, from the same furnace, run into molds, may be white and brit-

FIG. 917 A.

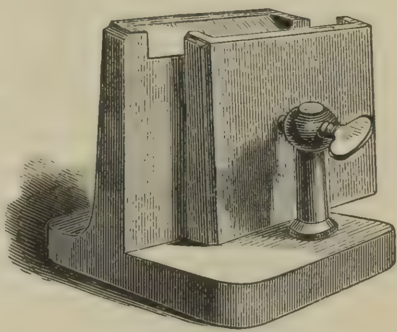


FIG. 917 B.

tle; or into sand molds, gray and less brittle; or into charcoal, dark gray and soft. Some such modification of the molecular arrangement of gold, due to its manner of cooling, is probably the correct explanation of the fact that a charcoal mold yields, other things being equal, a tougher ingot than iron.

An apparatus is now in use which combines the crucible and ingot-

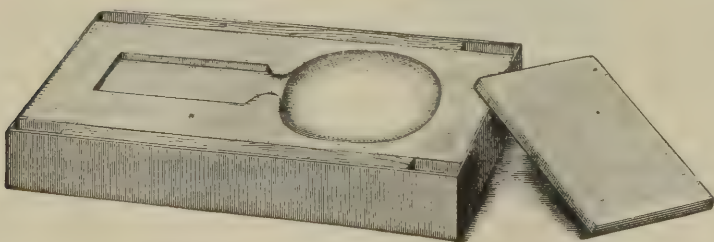


FIG. 918.

mold, in which a crucible, or molded carbon, communicates with an ingot-mold, both held in position by a clamp underneath and swiveling on a cast-iron stand. The metal to be melted is placed in the crucible, and the flame of a blowpipe is directed on it until it is perfectly fused. The waste heat serves to make the ingot-mold hot, and the whole is tilted over by means of an upright handle at the

back of the mold. A sound ingot may be obtained at any time in about two minutes.

The charcoal ingot mold is easily made. Select a fine-grained piece; saw in half and make smooth by rubbing the surfaces together. Then make the matrix in one of three ways: either cut the shape required out of one-half, with the proper gate; or bend a heavy wire into shape of the ingot and gate, and bind it between the surfaces; or saw off a charcoal slab, and after cutting out the shape of the ingot and gate, bind it between the surfaces. Those who have once used a charcoal ingot will seldom use any other.

After the ingot has become sufficiently cool, it may be placed on an anvil, and its thickness reduced to about an eighth of an inch with a hammer weighing from one to one and a half pounds. It should then be well annealed by being placed in the furnace, lightly covered with small pieces of charcoal, and heated until it assumes a uniform cherry-red color; or it may be annealed with a blowpipe. It may be necessary, during the operation of hammering, to subject it once or twice to this process to prevent the gold from cracking. If, notwithstanding this precaution, it should crack, it must be again melted, and refined with muriate of ammonia, etc. Sudden cooling does not make it brittle. On the contrary, some jewelers maintain that if plunged in alcohol and water it is softer than when slowly cooled. A little sulphuric acid in the water will give a bright surface to the plate by cleansing off the oxid of copper; but this acid pickle is only necessary for removal of the metal of the dies used in swaging, or of the borax used in soldering; in all other cases we prefer to have the oxid coating.

After the gold has been reduced to the thickness just mentioned and well annealed, it may be placed between the rolls of the mill, previously so adjusted as to be the same distance apart at both ends, and not so near to each other as to require a great effort to force it between them. The rollers, however, should be brought a little nearer to each other every time the plate is passed between them; and during this process they should be kept well oiled, so that there may be as little friction as possible. Many roll the ingot without any previous hammering. In the process of rolling care must be had to anneal often, and to roll in one direction until sufficient width of plate is obtained; then, before cross-rolling, be sure to anneal, else the plate will be very apt to crack.

Rolling mills for gold are variously constructed. Some are very simple, while others are quite complex, having a great deal of machinery connected with them. The rollers also vary in length from three to five inches. For the gold plate used by dentists, they need

not be more than three or three and a half inches long. Fig. 919 represents a form of rolling mill, with the cog-gearing. It is a strong but simple mill, and is very well suited to the dental laboratory. The set-screws at the top are turned with a rod, and must be both moved alike, else the plate will be thicker on one side, and will curve laterally in rolling.

Fig. 920 represents a more complicated mill. With such a mill, all the heavy rolling of a laboratory could be done without the aid of an assistant.

The thickness of the plate may be determined by a gauge plate. That which is to serve as a basis for artificial teeth for the upper jaw may be reduced until it fits the gauge at 25, 26, or 27, according to the quality of the plate and the depth or irregularity of the arch. For the lower jaw, and for backings and clasps, it may range from 21 to 24. When the whole alveolar border and a portion of the roof of the mouth is to be covered, it may be a little thinner than when applied only to a small surface; also thinner when the arch is deep or irregular. The purer the gold is, the thicker must be the plate. When very wide clasps, too, are employed, it is not necessary that the gold should be as thick as is required for narrow ones; and low or wide backings need not be so thick as long or narrow ones. Lower plates, if wired around the edge or doubled over the middle third, may be made of the same thickness as an upper plate. But these are matters which the judgment of the dentist alone can properly determine, and, conse-

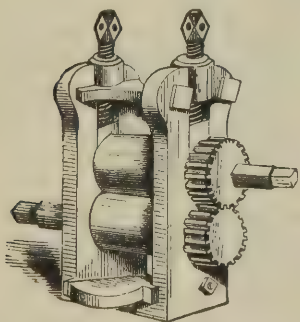


FIG. 919.

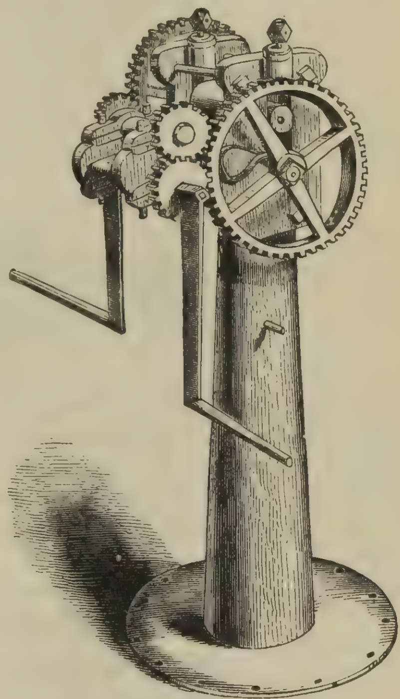


FIG. 920.

quently, no rules can be laid down upon this subject from which it will not sometimes be necessary to deviate.

Gauge plates are, unfortunately, not uniform. For many years the most reliable were those manufactured by Stubbs. But it is difficult

FIG. 921.

to procure them. At the same time it is very important that some standard should be adopted in the profession. Under these circumstances we approve the suggestion of the late Dr. S. S. White, who recommended the gauge plate given in Fig. 921, which has been adopted by the principal brass manufacturers of this country.

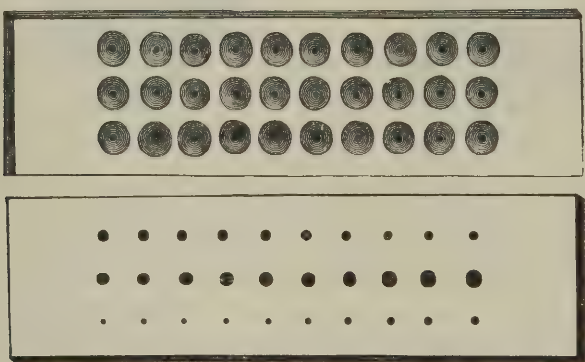


FIG. 922.

It may be necessary sometimes to make gold wire for spiral springs or other purposes, also hollow-tube wire. A draw plate (Fig. 922), strong pliers, and a bench vise (Fig. 923) are the necessary tools for

this purpose. The draw plate should be of the hardest steel, with the holes diminishing very gradually. The pliers should be rough at the end, for grasping the wire, which must be often annealed during the process.

Tube wire may be obtained from the jewelers, by whom it is known as joint wire. But it is seldom over sixteen carats fine. For use in the mouth it should be not less than twenty carats; but for many purposes pure gold or platinum tubing is better. It is easily made as follows: Take a small strip of plate one-fourth of an inch wide, one or two inches long; slightly taper one end; bend it around a mandrel or common knitting needle, and pass it into one of the larger holes of the draw plate. Then with the pliers draw it through and repeat until the edges of the strip meet. Remove the mandrel

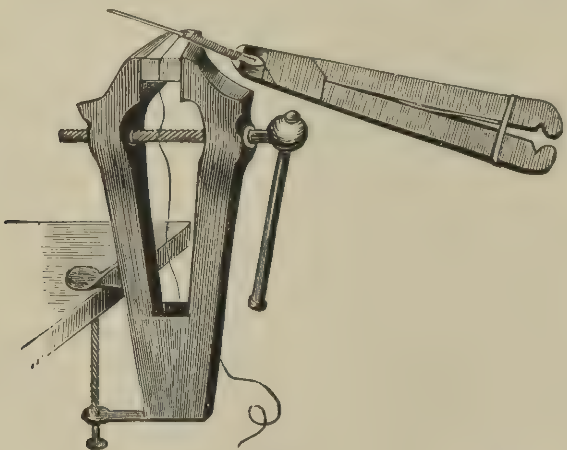


FIG. 923.

and solder the seam with fine gold or else pure gold. Lastly, select a mandrel or needle, the size of the required tube, and draw the wire until it has the proper thickness. If the bore is to be smaller than any needle at hand, the last drawing may be done without the mandrel.

The simplest method of winding wire into a spiral spring is to secure it between two blocks of wood, held between the jaws of a small bench vise, as shown in Fig. 923. The upper end of the wire is then grasped by a hand vise or sliding tongs, in connection with a spindle or steel wire the size of a small knitting needle, six or eight inches in length. The spindle, resting on the blocks of wood, is made to revolve, and by this movement the gold wire is drawn through the blocks and wound firmly and closely round the steel rod.

GOLD SOLDER.

In making gold solder, the materials employed for the purpose, if not pure, should be refined separately. Unless this is done, it will be difficult, and often impossible, to ascertain their relative purity, which should be known to insure the desired result. The gold is placed in a clean crucible with a little borax, and as soon as it has become perfectly melted the silver, and afterward the copper, are added. When all are melted, the alloy may be immediately poured into an ingot mold, previously warmed and oiled. The process of hammering and rolling the solder is the same as that described for gold plate. In consequence of the large amount of alloy in solder, it is sometimes so stiff, and even brittle, as to be with great difficulty rolled; this difficulty is increased by the fact that its low fusibility makes it not very easy to anneal without melting. This is especially the case with solders in which zinc or brass is used.

In making solder into the composition of which zinc enters, the other ingredients must be thoroughly melted, then the zinc (or brass) introduced at the last moment, rapidly stirred, and the metal quickly poured. A piece of charcoal will be found better for making small quantities of solder than a crucible.

The solder employed for uniting the various parts of a piece of dental mechanism should be sufficiently fine to prevent it from being easily acted on by the secretions of the mouth.

If pure gold is used, the solder will be of finer quality than if twenty-two-carat gold is used, but will not flow quite so readily. But twenty-two-carat plate may be used, if its alloy is known, by making due allowance for the amount, which is easily calculated by use of preceding rules. The following makes a solder sixteen carats fine, and may be used for eighteen- or twenty-carat gold plate; it flows very freely:—

No. 1.—	Pure gold,	6 dwts.
	Fine silver,	1 "
	Roset copper,	2 "

By adding one or two grains of zinc, a solder may be made that will flow at a lower temperature than that made by recipe No. 1. It will also have a finer gold color; but it is apt to impart to the piece a brassy taste, and for this reason is objectionable. Zinc solders are apt not only to have a brassy taste, but also to become brittle after long use.

The following formulas will give solder fourteen carats fine; the first from Johnson Bros.:—

No. 1.		
Pure silver,	2½ dwts.	
" copper,	20	grs.
" zinc,	35	"

No. 2.	
American gold coin,	$10
Pure silver,	4 dwts.
" copper,	2 "

The following formulas from the *American System of Dentistry* are suitable for bridge- and crown-work, and are twenty carats fine :—

No. 1.

American gold coin (21.6 carats fine) $10 piece,	258 grs.
Spelter solder (composed of equal parts of copper and zinc)	20.64 "

No. 2.

Pure gold,	5 dwts.
" copper,	6 grs.
" silver,	12 "
Spelter solder,	6 "

Dr. D. H. Goodno's formula, which is said to give a gold solder which is remarkably tough, flows readily, and does not discolor in the mouth, is composed of the following alloy :—

Pure gold,	40 grs.
" silver,	2½ "
" copper,	2½ "
" zinc,	2

In the melting process the zinc is rolled in gold foil and placed in the crucible and covered with borax. The copper and silver are then added and also covered with borax, and the whole melted. To use this alloy for a twenty-carat plate, 5 dwts. of pure gold are added to 1 dwt. of the alloy ; for eighteen-carat plate, 5½ dwts. of pure gold to 1½ dwts. of the alloy.

The following formulas, taken from Dr. Richardson's work on "Mechanical Dentistry," furnish solders (No. 4) over fifteen carats fine, and (No. 5) eighteen carats fine :—

No. 4.	
Gold coin,	6 dwts.
Silver,	30 grs.
Copper,	20 "
Brass,	10 "

No. 5.	
Gold coin,	30 parts.
Silver,	4 "
Copper,	1 "
Brass,	1 "

Other recipes might be added, but the foregoing have been found with us to answer every purpose. More difficulty arises in the use of solders from a wrong method of soldering than from defect in the solders themselves. Almost every dentist will be found to have his

favorite recipe, which "invariably flows smoothly." The very fact that so many hundred different solders work so well goes far to prove what we have said. Some will boast of using a solder as fine as the plate. This may be true if by "fineness" we mean simply carat valuation. But a solder containing two grains of zinc to the dwt. is in no true sense as fine as a plate alloyed with that amount of copper; yet both are twenty-two carat metal. Rules for the management of solder, plate, and blowpipe, in the act of soldering, will be hereafter given.

CHAPTER VIII.

CUPS AND MATERIALS FOR IMPRESSIONS OF THE MOUTH—PLASTER MODELS.

In the construction of a dental substitute, mounted upon a plate or base, it is necessary to obtain an exact model of the parts upon which it is to rest and to which it is to be attached. For this purpose a perfect impression of these parts must be obtained, involving—first, the choice of a suitable impression cup or tray; secondly, the selection of an impression material.

IMPRESSION CUPS OR TRAYS

must be of such size and shape as to permit their easy introduction into the mouth; also they must follow, as nearly as possible, the out-

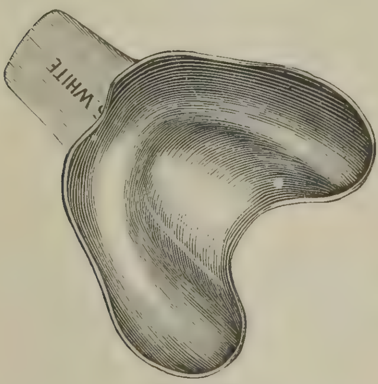


FIG. 924.

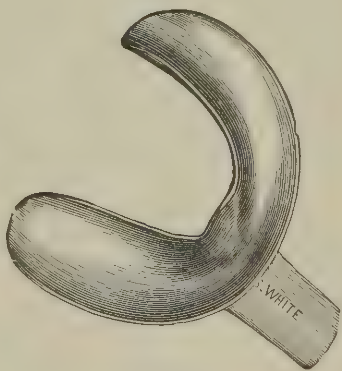


FIG. 925.

line of the surfaces to be copied, allowing a uniform space of one-fourth or one-eighth of an inch for the material. These trays are

sometimes called mouth cups; but we think the name given, and now generally used, is greatly to be preferred. They are of two kinds, metallic and gutta-percha.

Metallic trays were formerly made of sheet tin, cut into shape and soldered, and were so imperfect that it was very often necessary to swage metallic trays to suit special cases. The depots now supply an excellent assortment of well-shaped Britannia impression trays, of which sixteen will constitute a full set; namely, six sizes for full upper cases, and three for full lower; three sizes for partial upper cases (in these

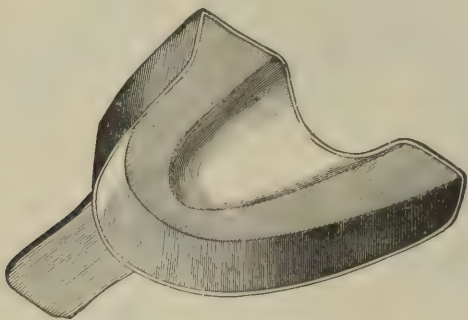


FIG. 926.

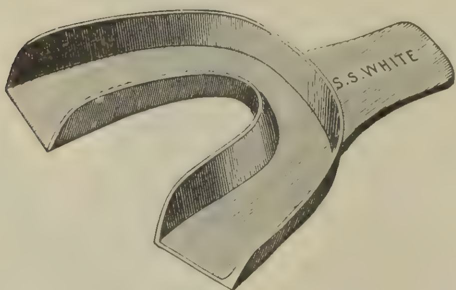


FIG. 927.

the outer rim rises at a right angle), and four for partial lower (these trays have a depression or a place cut out to receive the front teeth).

Figs. 924 and 925 illustrate full upper and lower impression trays.

Figs. 926 and 927 illustrate partial upper and lower impression trays with flat bottom and square sides.

Figs. 928 and 929 illustrate adjustable impression trays. In taking impressions of deep, narrow mouths, or where a masticating tooth standing alone widens the jaw at a particular point, it is sometimes desirable to be able to readily adjust the size and shape of the tray

used. Upper, Fig. 928, and lower, Fig. 929, impression trays have been designed to meet this want. Either of these can be made into a partial tray by cutting off one side.

FIG. 928.

Fig. 930 illustrates Southwick's upper impression tray with raised palatine edges to prevent the plaster from slipping off.

Fig. 931 illustrates a partial lower tray with an opening to allow the front teeth to pass through and the tray to pass down to the maxillary ridge. A piece of wet paper is placed over the opening when the tray is filled with the plaster-batter.

Fig. 932 illustrates Dorr's lower impression tray with posterior lingual wings, which enable the operator to obtain an accurate impression of the jaw on either side of the tongue. These wings may easily be spread apart, or brought toward each other, or twisted, or cut away to adapt the tray to nearly any size or shape of the edentulous lower jaw.

Fig. 933 represents Dr. Franklin's tray for full lower impressions; the slot and upper groove permit secondary pressure of the wax or plaster, after the surplus material is forced up, as it is pressed on the alveolus.

"This tray, or rather double tray, has a groove or space in its center all the way round. The advantages of this groove are, that, when the lower part

FIG. 929.

of the tray is filled, and the upper part one-fourth full of plaster, and placed in position over the ridge, the operator, with the end of the

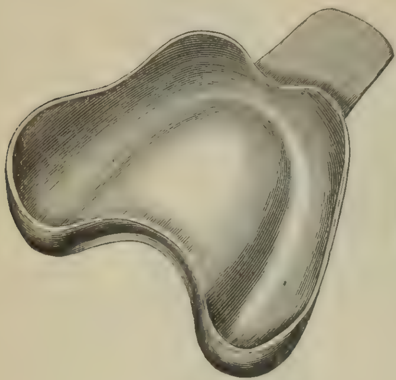


FIG. 930.

FIG. 931.

finger or other suitable means, can gently agitate the whole mass of plaster in the tray, and thus prevent air-bubbles, blanks, or other im-

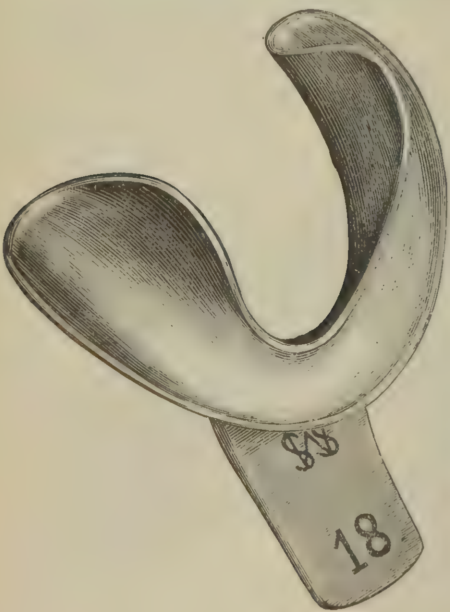


FIG. 932.

FIG. 933.

perfections on the surface of the impressions. The peculiar shape of the outer flanges of this tray is such as to distend the cheeks, while the

lower inner edges, pressing upon the submaxillary and sublingual

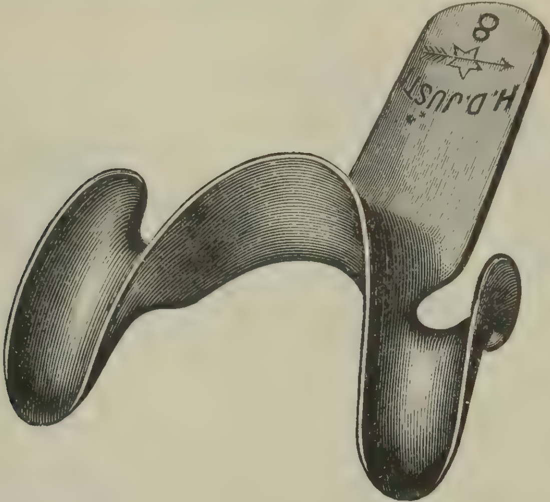


FIG. 934.

glands, depress them sufficiently to prevent any fold or ligamentous attachments from being embraced by the impression.

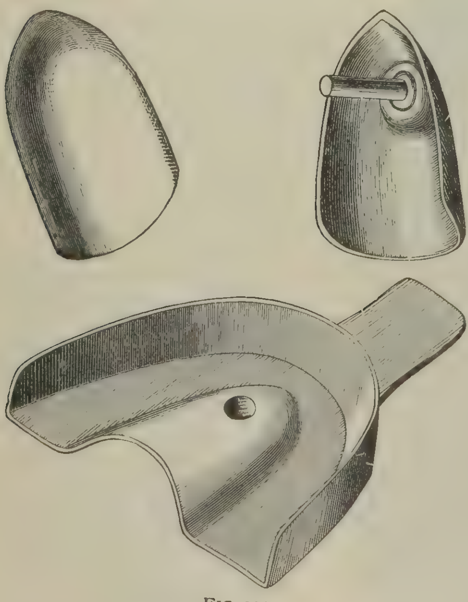


FIG. 935.

Fig. 934 represents a tray for lower molars in partial cases.

Fig. 935 represents the Wardle tray, which is supplied with a movable palate plate, so adjusted that it is capable of forcing the center of the impression material against the highest part of the arch, as well as laterally against the palatal sides of the necks of any remaining teeth.

Fig. 936 represents Fouke's impression tray, by which it is claimed a correct impression in all variety of cases, both partial and full, can be obtained. It consists of a metallic portion with a canvas lining.

The design of the tray suggests of itself the manner of using it; which consists of the ordinary pressure against the metallic part of

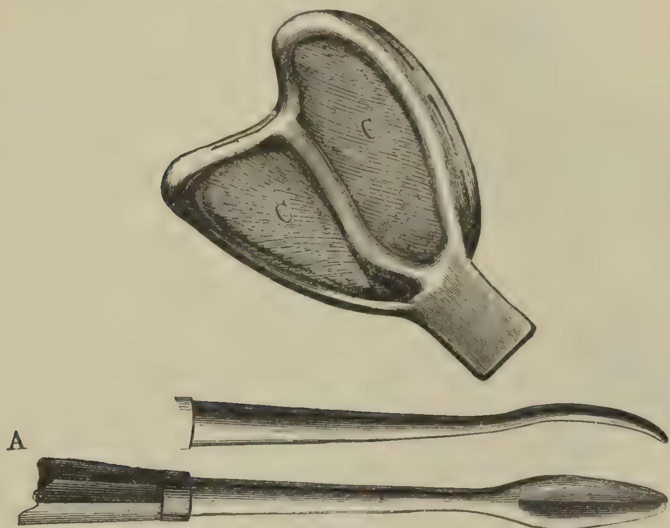


FIG. 936.

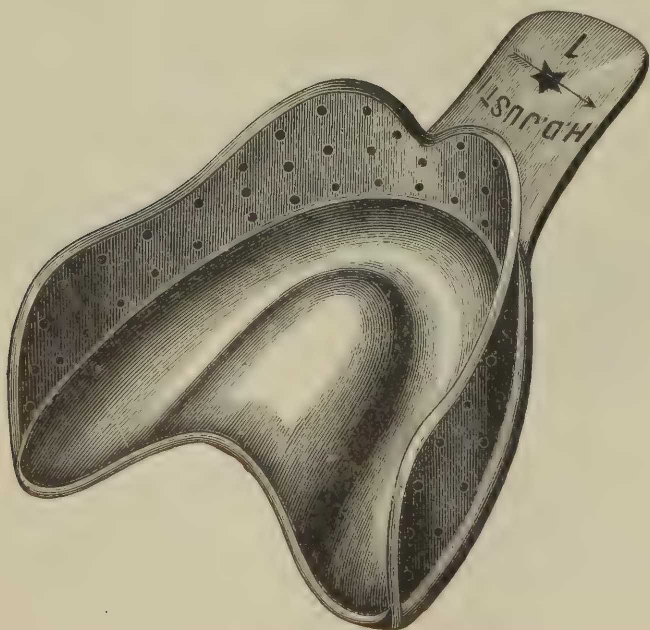


FIG. 937.

the tray, in connection with a proper distribution of pressure with the fingers and compressing instrument A, against the canvas lining of the tray, C C; the latter pressure must be made with a degree of firmness and steadiness sufficient to compress thoroughly all parts of the mouth.

Fig. 937 represents Weirich's flexible rim tray to retain plaster that may break away from outside of ridge, and enable it to be replaced.

Exceptional cases, which no form of purchased tray will suit, may require a swaged brass, zinc, copper, or silver tray; or a tray cast out of Britannia metal, or other tin alloy. The process of swaging will hereafter be described; also, the method of molding a tray from a pattern of wax. Most of these cases, however, may be met by bending, hammering, or cutting the ordinary Britannia tray; remembering always that a wise economy never hesitates to sacrifice the tray to secure excellence of the impression or the saving of time. Without this adaptation of the tray to the form of the alveolar ridge and palate it is impossible, in certain mouths, to get a good wax or gutta-percha impression. Fig. 938 illustrates a partial upper tray for one or two teeth, which is useful in pivoting and bridge-work.

FIG. 938.

Figs. 939 and 940 illustrate partial upper or lower trays.

Trays similar in shape to the Britannia, but not in so many varieties of size, are also made of hard rubber and porcelain. The first cannot easily, and the latter cannot at all, be modified in shape to suit special

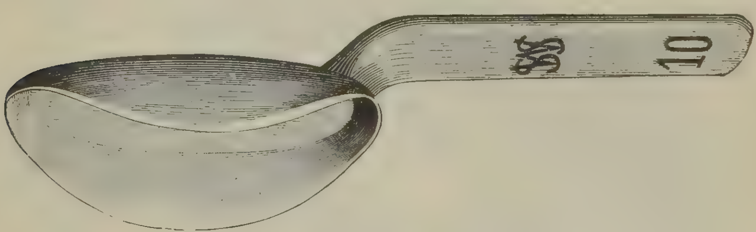


FIG. 939.

cases. The porcelain trays are handsome and clean looking, but they are easily broken; and when plaster is used, it will sometimes leave the glazed surface and cling to the mouth. We, therefore, prefer the Britannia tray, unless the case requires Prof. Austen's gutta-percha tray.

These trays were originally devised to meet a difficulty incident to

vulcanite partial pieces. Perfect impressions of dove-tailed interdental spaces, and the lingual side of molars and bicuspids, often undercut, are impossible in wax or gutta-percha. Yet Prof. A. regarded this as essential to the proper construction of a partial vulcanite set of teeth.

FIG. 940.

They are thus made: Take a wax impression and make a model; in partial cases, brush over the teeth of the model one or two layers of thin plaster, to fill up all undercuts, and to make the plate fit loosely; saturate the model with water, and mold over it a gutta-percha tray. This last is done, not by using the gutta-percha in sheet, but by first making into a ball; then working it from the palate outward, leaving a thick mass in the center. It should be, on the inside, from one-fourth to one-half of an inch thick, so as to be stiff and unyielding; but on the outside not more than one-eighth or one-sixteenth thick, so as to be slightly elastic and yielding. The whole inside of the tray must be roughened up with a scaler or excavator in such a way that the plaster can take firm hold. In most partial cases, the impression will have to be removed in sections; the inside remaining entire, but the outside and the parts between the teeth coming away separately. In certain cases it is necessary to partially cut through the tray before putting in the plaster, and usually upon the thick masses of gum which fill the interdental spaces. A cut on the inside, in line with the ridge, gives pliancy to an otherwise rigid tray, and permits its easy removal. When it is desirable to extend the tray around the entire arch, so as to get an exact plaster impression, not only of the gum but of all the remaining teeth, this rim of gutta-percha must be slit at two or three points, to give that pliancy which is a chief merit in this form of tray. These trays have no handle, but are removed by inserting a plugging instrument into a small hole previously made in the back part of the tray, where it is thickest.

IMPRESSION MATERIALS

Must possess the following properties: (1) Plasticity in sufficient degree to copy mucous tissues, avoiding the extremes of softness, which permits them to flow from the tray, and of hardness, which requires excessive pressure. (2) The property of hardening within a short time, and under conditions not incompatible with the mouth. (3) Absence of expansion or contraction, except in very moderate

degree. It may also be added that the materials should not be such as, in taste, smell, or appearance, are calculated to disgust the patient.

There are four materials answering to these requirements, and possessing properties as distinctive as the sources whence they are derived. From the Animal kingdom, BEESWAX; from the Vegetable kingdom, GUTTA-PERCHA and MODELING COMPOSITION; from the Mineral kingdom, PLASTER. After their separate description, a brief review of their distinctive properties will be given. No one of the four can be dispensed with; no one should be exclusively used.

Beeswax.—Formerly the only material used, and is yet very useful for certain cases, and is absolutely indispensable for other dental purposes. The best wax is from virgin combs, and has a rich golden color. Commercial adulterations with tallow, etc., injure it, and mixture with resin makes it harsh and difficult to manage. Gutta-percha is sometimes incorporated with it to give hardness in warm weather; bleached or white wax is also used for the same purpose.

A very valuable addition is paraffine. Pure paraffine is very plastic, softening at a low temperature (100°); but the folds of soft paraffine have no tendency to reunite, and consequently the mass is full of easily separated flakes or layers. It imparts this property to wax, if in too large proportion; but its moderate use greatly improves the wax. It causes it to soften at lower heat, makes it more plastic when warm, and harder when cool.

The depots furnish wax and its compounds in very pure, neat, and convenient forms; so that there is now little necessity for the dentist to spend the time once demanded to reduce the thick cakes into serviceable shape. It may be well, however, to state briefly how to prepare wax for impressions. Melt and pour into cakes one-quarter of an inch thick; cut into pieces about two inches square; and when nearly cold roll on a wet board, with a wet wooden roller, to one-half or one fourth this thickness. This breaks down the crystallization, and reduces it to a form very convenient for softening when wanted for use. It may be softened over a broad flame, or before a fire or stove, or in warm water. In using dry heat be careful not to melt the surface, or give the peculiar whitish appearance that precedes melting. In using water, have a large quantity, to secure uniformity of temperature, and keep it at 120°–130° Fahrenheit. Below this it will not yield readily to the gum; above this it becomes adhesive.

Some practice is necessary in knowing the proper quantity of wax to use in the tray; the usual mistake is to take too much. Select a tray of proper shape and size; if the arch is a deep one, put some hard wax or gutta-percha in the center to force up the wax at that point. This is much better than to have a hole in the tray through

which to make pressure with the finger. Such trays are worse than useless, for it is impossible to make secondary pressure without injury to other parts of the impression, except in case of wax projecting above the tray, outside the ridge. Put the wax in the tray; smooth the surface, which should be a little softer than the body of the wax; then introduce and press against the gums or teeth with a steady, uniform, and moderately strong pressure; also, as nearly as possible, in a direction at right angles to the plane of the alveolar ridge.

The wax above the tray is pressed against the gums on each side, so that an exact impression may be obtained of all the depressions and prominences on the outside of the arch. But this must be done with great care, holding the tray firmly and pressing the finger against the cheek or lip, rather than directly upon the wax. It is much better in all cases to have the sides of the tray high enough to give the wax support at all points. For this purpose, it becomes necessary sometimes to swage or cast a special tray. Very perfect wax impressions can be taken in such trays. On the removal of the trays and wax from the mouth, the greatest precaution is necessary to prevent injuring or altering the shape of the impression. Holding the handle firmly, it must be drawn directly downward, in case there are front teeth, in the direction of the axes of these teeth. Impressions of a full upper arch sometimes adhere very tightly. They can generally be loosened by drawing up the cheek and lip on one side or both sides alternately; or by a slight cough, which, acting upon the palate, admits air behind and above the impression. Any violence or twisting motion injures the impression; in wax or gutta-percha such defects cannot be detected until, on completion of the plate, maladjustment creates suspicion of its cause. The wax must be kept in the mouth long enough to cool and harden. A small piece of ice in a napkin, held against the under side of the tray, will rapidly harden it. This simple plan is preferable to the use of double trays, into which a stream of cold water is injected. The latter are not only expensive and troublesome to use, but they endanger the accuracy of the impression. All wax impressions, unless for models on which other trays are to be made, should be hardened by artificial cold; it greatly helps to prevent change of shape on withdrawal. If the surplus wax, by contact with the lips or teeth, injures the impression, then, if it is a full case, cut off the surplus, dip into warm water, and introduce the same impression a second time; but if it is a partial case, it must be taken anew, for the teeth cannot, with any accuracy, enter their wax impressions.

Gutta-Percha.—This very valuable material will be found useful in taking impressions of the lower jaw and in some partial cases, also

frequently in full upper cases where the teeth are set on a vulcanite base. The manipulations are different, accordingly as we wish to make the gutta-percha adhere to the tray, or wish it to part from the sides of the tray as it shrinks on cooling. In the first case, soften in water heated to 180°–200° Fahrenheit; dry off the water; hold for a few moments over a flame, and press into a warm tray; keep the fingers wet, to prevent the gutta-percha from sticking, but do not let water get between it and the tray. In the second case, keep the surface of the gum wet, and introduce it into a cold and wet tray. When the tray is filled, place again in water at 180°; then press it somewhat into shape, and introduce into the mouth. Pressure must be more gentle than for wax; it must be kept longer in the mouth, and ice should be used to cool it. Be very careful, in partial cases where there is much undercut or a dovetail space between teeth, not to make the gutta-percha too hard, else it will be almost impossible to get it out of the mouth.

Gutta-percha copies surfaces with all the accuracy of plaster, but, although harder than wax, it is more apt than plaster to change its shape upon withdrawing it from the mouth. Its characteristic peculiarity is contraction on cooling; but this is controlled, when required, by the directions above given for making it adhere to the tray. It is less easily manipulated than wax, and not so generally useful; but its property of contraction admirably adapts it to certain cases in which plates, otherwise accurate, fail, because too large and loose.

Gutta-percha for impressions is supplied in convenient form by the depots. The native color is dark, and calculated to repel fastidious patients. For this reason, also to give it body, it is incorporated with about its own weight of white oxid of zinc, magnesia, or chalk, and a pinkish color given by vermilion. Thus prepared, it is less sticky when softened, and becomes harder, when cool, than the crude article.

Modeling Composition or Compound is composed of gum dammar, stearine, French chalk, with carmine to color it, and a perfume to render it pleasant. Four varieties are manufactured—the soft, the medium, the hard, and the extra soft, differing as to the quantity of stearine and chalk incorporated with the gum. Modeling composition is an excellent material for impressions, as it copies very accurately and affords a smooth model. The best manner of using it is to soften this material in boiling water contained in a shallow vessel. When it is thoroughly softened, and not too hot to handle, the tray for its reception should be slightly warmed, into which, after drying with a cloth, it is introduced in the same manner as wax. After it is

applied to the mouth, it is allowed to cool somewhat, after being pressed around the outside of the alveolar ridge.

The same care is necessary in removing it from the mouth as with wax, and it should be immersed in cold water at once, to harden it. Before pouring the plaster the impression should be dipped in cold water. To remove an impression of this material from the plaster model, both are immersed in boiling water, where they should remain until the compound becomes soft, but not adhesive, when it is easily separated from the model.

Plaster—Gypsum, Sulphate of Lime, or *Plaster-of-Paris*—consists of 28 parts lime, 40 of sulphuric acid, and 18 of water; the first its mineralogical name, the second its chemical, the third its commercial. A beautiful translucent variety of gypsum is known as *alabaster;* the transparent crystalline variety is called *selenite.* That, however, used in agriculture and for calcining is in amorphous masses of a grayish or bluish-white color. When exposed to a heat between 300° and 400° Fahrenheit, most of the water of the gypsum escapes. It is then known as calcined plaster, plaster-of-Paris, or simply plaster. After being properly calcined and pulverized, if mixed with water to the consistence of thin batter or cream, it hardens in a few minutes, and acquires great solidity. The plaster has chemically reunited with a portion of the water, while another portion is mechanically held in the porous mass, and may be driven off by drying. During the process of consolidation it expands, in consequence of the absorption of the water by the particles of plaster. If the plaster is very fine-grained, this absorption takes place quickly, and the expansion occurs while the plaster is soft. But coarse-grained plaster sets before the particles become thoroughly saturated; hence it continues to expand, more or less, for some time after solidification. There is a great difference in the quality of plaster. That used for taking impressions of the mouth (and, in fact, for all dental purposes) should be of the best description, well calcined, finely pulverized, and passed through a sieve of bolting cloth previous to being used. The idea of taking impressions for full sets of teeth with plaster originated, we believe, almost simultaneously with Drs. Westcott, Dunning, and Bridges, by whom and the profession generally it was regarded as adapted almost exclusively to full impressions. Prof. Austen, however, introduced a method of using it in connection with gutta-percha trays, which makes it, in the hands of a careful manipulator, universally applicable to every case in which a dental appliance is called for. He would, however, by no means recommend such universal application, claiming only that the gutta-percha tray will give with plaster a correct impression of partial cases of greatest irregularity, where the use of wax or gutta-percha would be

impossible. A composition of plaster-of-Paris, white sand, sulphate of potash, and Venetian red, a formula suggested by Dr. Teague, forms an excellent impression material.

For plaster impressions in ordinary full cases, upper and lower, select a Britannia tray, about one-eighth of an inch larger than the alveolar ridge, and, in case of a deep upper arch, build up with wax, so as to give support to the soft plaster; also supply with wax any deficiency in the size of the tray at the back part or around the outside edge. In exceptional cases requiring a special tray, a gutta-percha one will be found to be much easier made than a swaged or cast metallic tray. If properly shaped, it will fully answer the purpose.

The late Dr. J. B. Bean's practice was to take a wax impression, make model and dies, and swage a plate; then solder a strip from ridge to ridge, to hold a stick, which was to act as a handle in removing the impression. He then heated the plate, and coated the palatine surface with shellac, pressing a lump of raw cotton against the adhesive resin. The cotton fibers caused the plaster to adhere firmly to the plate, thus avoiding the great annoyance when scales of plaster, so thin as in this kind of tray, break off. The process is troublesome, but the results are very satisfactory.

To take a plaster impression, place a patient in a common chair, and after the tray is introduced, incline the head forward, holding it in place with a gentle but steady pressure upon the center of the tray. The plaster should be very fine-grained and mixed rather thin, to get rid of air bubbles. If necessary, a little salt or a few grains of sulphate of potash should be added, to quicken slow-setting plaster. The necessity for salt and quantity to be used should not be left to conjecture; hence the importance of setting aside in a well-closed vessel a quantity of "impression plaster." Also, if the plaster is "slow," set aside a large bottle of salt water of the exact strength required to make the plaster set properly. There will, in this way, be no danger of the plaster setting too quickly or too slowly. If made to set too rapidly, it hurries the operator and increases the risk of failure; if it sets too slowly, both patient and operator become wearied before it is hard enough to remove. Tepid water promotes the setting of plaster. It should require about three minutes to harden after it is introduced into the mouth, which must be done when it is stiff enough to allow the plaster to be molded into some shape, and yet soft enough to permit no sharp points or angles on its surface. If softer than this, the slightest pressure forces it out of the tray to run sometimes out of the mouth, sometimes on the tongue and fauces. This also is apt to occur if an excess of plaster is used. These unnecessary accidents are well calculated to prejudice patients against plaster, and, perhaps, against the operator.

The hardness of plaster in the mouth can be ascertained by the watch, when the exact time required for setting is known, or by testing some of the plaster remaining in the bowl. As soon as it breaks with a sharp fracture, it should be removed. To keep it in much longer than this is apt to give unnecessary pain and difficulty in removal, owing to the absorbing property of the hardened plaster, which causes it to cling with great tenacity to the mucous membrane.

Full lower impressions are generally easy to withdraw ; but some full upper ones adhere very tenaciously. Raising the cheek on one side or in front, and depressing the tray, will detach most cases. This can be done, in case of plaster, without risk of injuring the shape of the impression. If this does not loosen it the patient may be requested to give a slight cough. Where there is much undercut, the plaster will break ; but it can readily be replaced. Sometimes the action of the cheeks and lips, or of the soft palate, will loosen the impression ; or an instrument may be used to press up the palate, and thus cause air to pass in at the back, when it may be easily removed. Complicated modifications of the tray to facilitate removal are of little value, and make an unnecessary multiplicity of apparatus.

In partial cases, the outer rim (which for this purpose is made elastic, or else in sections) is first detached, and the central portion then loosened by an instrument inserted into the *back* part of the gutta-percha cap. If there should be many broken, detached fragments, either loose or caught in dovetail spaces between the teeth, these must be very carefully removed ; and when the surface moisture has dried off, they must, with the utmost nicety, be replaced in the impression. This is sometimes a tedious and difficult operation ; but it is not trouble misapplied, since it is the *only* way in which perfect impressions of difficult partial cases can be obtained. Should the detached plaster be from a very irregular surface, its readjustment is made much easier by touching the gutta-percha at that point with a camel's-hair brush dipped in very hot water. The fragments being all adjusted and the outside ones secured by a little resinous cement, should there be much broken surface on the inside, it is best to varnish heavily with sandarach to cement the pieces ; otherwise, let the surface be prepared, as in full sets, for preventing the plaster of the model from adhering.

Wax and gutta-percha require nothing for this purpose, or, at most, a very thin layer of oil. Plaster impressions may be rendered separable : 1, by an alcoholic varnish of sandarach or shellac, or a diluted solution of soluble glass, with a little oil upon the varnished surface when dry ; 2, by saturating it with as much oil as it will take up without standing upon its surface ; 3, by coating the surface with a dilute soap mixture. The varnish may be either transparent or colored ; the

transparent varnish consists of gum sandarach, ℥v; alcohol, Oij; the colored varnish consists of the same proportions of gum shellac and alcohol. The gum is added to the alcohol and digested over a moderate heat until it is dissolved. The varnish is best applied with a small bristle brush; the oil and soap water with a camel's-hair brush or a stiff, pointed feather. The varnish must be kept well stopped, or from time to time diluted, so as not to become thick. The soap mixture needs, occasionally, renewal, as the plaster gradually neutralizes its oil and renders it unfit for use.

Some dentists take plaster impressions, in certain cases, thus: First, a wax impression, as usual; then enlarge, by pressure, or by cutting out the depressions formed by teeth or a prominent alveolar ridge; lastly, they pour in a thin layer of plaster, and repeat the impression. Others surround certain teeth with a collar of wax, preparatory to taking a plaster impression.

The last is a troublesome method, very apt to fail, from the slipping of the wax collars; nor has it any superiority over a wax impression, to compensate the trouble. Dr. C. J. Essig suggests the following method for securing a plastic impression for partial cases: "An impression should first be selected of the proper size and shape; those with the flat floor are best for partial cases; the plaster should be mixed thin, almost as thin as water, adding chlorid of soda to facilitate setting. Plaster mixed in this manner does not become hard and unyielding as that mixed merely to saturation. Now oil the tray so that it will readily separate from the impression when hard, fill the tray as soon as the plaster thickens sufficiently, then, with a small spatula, place a layer of the soft plaster in upon the palatine surface; otherwise by enclosing the air in the deep portion of the arch the accuracy of the impression may be impaired. After this precaution the tray is placed in the mouth, and gently pressed up until its floor comes in contact with the teeth. When the plaster is sufficiently hardened, remove the tray, which, from its having been oiled, is done without difficulty; with the thumb and index finger break off the outside walls; the portion covering the palatine surface is then removed by the use of a blunt steel spatula, curved at the end in the form of a hook. The pieces are then placed back into the tray, where they will be found to articulate with perfect accuracy. Should the first attempt be rendered futile, by the tendency to nausea or troublesome gagging on the part of the patient, camphor water, as recommended by Dr. Louis Jack, may be used as a gargle, which will, in nearly every case, prove an effectual remedy."

The comparative value of the four impression materials—wax, gutta-percha, modeling composition, plaster—can only be determined by a

careful study of (1) their distinctive peculiarities; (2) the special requirements of different mouths; (3) the kind of base-plate and manner of its construction. The exclusive use of one is as reprehensible as the indiscriminate use of all. No one is best, nor can any be dispensed with. Disregard of this most important fact is a fruitful source of failure in impressions; failures arising neither from defect in the material nor lack of skillful manipulation in the operator, but from want of philosophical selection of resources.

(1) *Wax* demands strong pressure and is inelastic; also, it neither expands nor contracts on cooling. It copies a hard gum accurately, although it never gives the fine tracery of gutta-percha, modeling composition, or plaster. It also copies a soft gum, but not until the gum is either compressed or thrown out of shape by the strong pressure required. *Gutta percha* requires moderate pressure; is slightly elastic; also has, as its marked peculiarity, very decided contraction on cooling, which, however, is under control, as previously explained. Slight undercuts it will take, without dragging, as wax does; but, on the other hand, it will occasionally pass into very narrow interdental spaces and injure the impression in the effort to withdraw therefrom. *Modeling Composition* ranks next to plaster as an impression material, and when thoroughly softened in boiling water, and when not too hot to handle, will give an accurate impression under strong pressure and a much finer tracery than wax. *Plaster* permits only gentle pressure, taking impressions of softest tissues in natural position. It slightly expands in setting; but, in a rigid tray, this makes no appreciable increase in the size of the model. It sets so hard that it will break before leaving the smallest undercut; but, by virtue of the same quality, it can be used in the most marked cases of dovetail, or alveolar undercut.

(2) Alveolar and palatine surfaces, and their investing membranes, have a great variety of conditions. These must be carefully examined with reference to the properties, just named, of the impression materials. We have large or small arches; deep or flat ones; irregular or smooth ridges. The mucous surfaces may be uniformly hard or soft; the ridge hard and palate soft; or the more difficult combination of soft ridge and hard palate; or the ridge may be irregularly hard and soft. No one material can possibly be equal to these varying conditions.

(3) The mode of constructing the plate will often determine the choice of an impression material. A plate swaged upon a zinc die is smaller by the shrinkage of the die. Here—apart from shape or hardness of the parts—plaster would be best, wax next, gutta-percha the worst. A vulcanite plate is larger than the mouth, by the expansion of the model. Here, the contraction of gutta-percha will often prove a

very valuable compensation; also the compression of tissue made by the pressure of wax; special considerations must determine which of these to choose. Plaster is the most reliable impression material as a general rule, and is the only material in difficult cases worthy of any reliance. It may safely be asserted that the operator who cannot take an accurate plaster impression of any partial case, however difficult, has a very imperfect idea of the value of hard rubber. For the majority of partial cases, where swaged work is used, modeling composition, or wax, if properly manipulated, will give ample accuracy. Where, however, the undercut, and consequent dragging of wax, is very great, plaster must be employed.

Large, or hard, or irregular mouths are best copied in plaster, great deviations from normal size or shape requiring special trays. A gum of medium softness, but uniform, may be taken equally well in any material. This class of mouths have a wonderful adaptation to anything. Variations in size or form must determine the selection of the material. A gum of extreme softness, yet uniform, will give better results sometimes with one material, sometimes with another. It is often very difficult to determine beforehand; but, in case of failure, let the second impression be taken always with a different material. This is especially true of lower sets, where the gum behind is soft and flexible; it is hard to say whether the pressure of wax, or modeling composition, or the softness of plaster leaves the ridge in best condition; gutta-percha is often very useful in these cases.

Irregularity of texture in the mucous tissues is a fruitful source of trouble. A hard ridge, with a soft palatine surface, is easily fitted, and any impression material may be used. But the reverse condition will often require the firm pressure of wax or modeling composition upon the ridge; also in all cases of inequality of texture in the ridge itself. As a rule, subject to exceptions, a harder impression material than plaster is the best for these mouths, and occasionally (especially for vulcanite) the contraction of gutta-percha is useful; and scraping the model for a vulcanite plate, and building on a thin film of wax for a metal plate over the hard portions, is often serviceable in securing adaptation. For vulcanite plates, the model may be scraped slightly on either side of the hard palatal center.

For metal plates, a thin film of wax, about $\frac{1}{16}$ of an inch in thickness, is built along the entire hard palate, terminating in thin edges, the space to be thus covered varying according to the width of the mouth. The model should also be slightly scraped at the posterior edge of the surface to be thus covered by the plate on each side of the hard portion of the palate, so that the plate may be closely adapted at such points.

It is evident that an enumeration of all the complications which call for exercise of judgment in the selection of impression materials is impossible. By suggesting a few varieties, we hope to direct attention to a much neglected point, in our judgment of utmost importance. Routine practice, which inquires into the reason of nothing, and the one-idea system, with its "practice makes perfect" motto, are equally at fault. The future may reveal some new material; but the four we now have are alike important and indispensable.

PLASTER MODELS.

The model is made of calcined plaster, mixed with water so as to have the consistence of cream, too much water making the model fragile, whilst too little will prevent the escape of the air contained in the plaster, and the model will be porous. This last condition also greatly endangers the full flowing of the plaster into the inequalities of the impression.

The model, for convenience of description, is said to have a face, back, body, and sides—terms scarcely requiring explanation. The face, corresponding with the mouth to be fitted, requires greatest care; and the same directions answer for it in all models. The body of the model has different shape and size according to the use to be made of it. The back should be, in all cases, parallel with the face. The sides are to be either vertical or slanting, according to its uses.

In making models, we require a plaster table, with a rim to prevent scattering of waste plaster, having at least two drawers in front, a shelf at the back, also an opening for escape of waste plaster into a refuse box; a tight plaster-can and a bucket of water will complete the outfit of the table. The implements are two or three strong bowls, a plaster scoop, a spatula, an iron spoon, a plaster knife, a scraper, a sponge, and some camel's-hair brushes or wing-feathers of poultry. Sometimes a marble slab or slate is used for shaping the back of the model upon; but if the table is kept clean and smooth with the scraper, this is not essential; since, in any case, a piece of wet paper should be laid down to permit the ready removal of the model, for the purpose of shaping, whilst yet rather soft.

The most troublesome models are the thick ones for sand molding. The surface of the impression being prepared as above directed, the tray is surrounded with a rim of wax, waxed cloth, sheet lead, or tin foil, fitting closely, to prevent escape of plaster, and about two inches deep. The rims should be slightly curved, to give, when placed around the trays the requisite flare. Models made in such rims need trimming with the knife. To avoid this, and also to give greatest possible smoothness and regularity to the sides, flaring rings of sheet

tin may be used as follows: Set the impression level on the table, and surround with some soft, plastic material, such as potter's clay (wet newspaper made into a pulpy mass is perhaps the most convenient), and into this set a ring of such size as will give a proper shoulder to the model. Fig. 941 shows such a ring arranged for making such a model for plastic work, such as vulcanizable rubber, the models for which need not be very deep. For a sand model the ring should flare, should conform more to the shape of the tray, and be smaller. For the dipping process of making counter-dies and dies, the model needs no specially nice trimming. For the fusible-metal process, the model should be cylindrical and not flaring. These are the three forms of thick or deep models.

The shallow models are usually made without rims. The impression

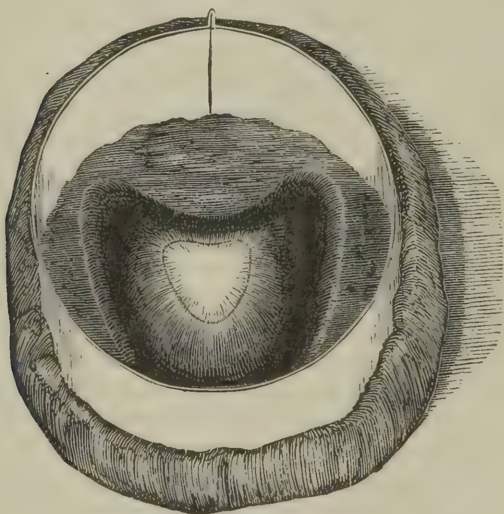


FIG. 941.

is filled, then turned down, when the plaster has set sufficiently to permit it, on the remaining plaster, which has been poured on a strip of wet paper placed on a smooth, flat surface. Whilst plastic it is shaped with the spatula. If for vulcanite or other plastic work, it may be taken up while soft enough to dress with a sponge. But if the shallow model is to be used in sand molding or in Dr. Gunning's process, it is allowed to harden and is then trimmed with the knife. In vulcanite models it will save time and insure greater accuracy in articulation to extend the model at once and make the articulating portion, if no metallic articulating frame is to be employed, as will be fully explained when describing the process of articulation. The sides of vulcanite

models need no shaping except such as neatness and convenience in handling require, since they are subsequently set into the flask; but they should be no larger or thicker than strength requires.

When rims are used, the impression should rest upon the plaster table; if set level, the back will necessarily be parallel with the face, since the thin plaster poured into the rim finds its level. In making shallow models the impression is held in the hand, thus permitting the flow of the plaster to be aided by moving or tapping it. As before stated, wax or gutta-percha needs no oiling; plaster may be oiled or soaped, or else varnished and oiled; it must also be saturated with water just before pouring the model.

Calcined plaster for models should not set too rapidly, as this will cause haste with its attendant dangers. Coarse plaster makes a stronger model, but it has greater expansion. Gum-water, or size, retards the setting, but makes the model very hard; salt quickens the setting, but should not be used for any models which are to be kept

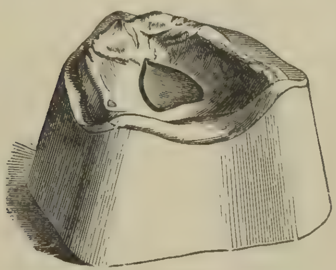


FIG. 942.

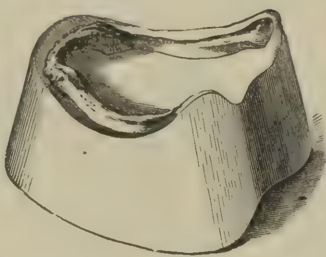


FIG. 943.

as permanent records of the case. It is better to add the plaster to the water than the reverse; it makes smoother work by permitting the escape of the air; it also, by the amount of unsaturated plaster, permits the operator to gauge the stiffness of the batter.

In all cases the face of the model is the part first made. The thin freshly-mixed plaster is first to be carefully run into the depressions of the teeth or their ridges. A brush or feather is necessary when the tray is stationary; when in the hand, motion or tapping or jarring will cause the plaster to flow as desired. Perhaps the surest way to prevent defects on the face, from confined air, is to have a little surplus water in the tray. The plaster (which in this case must not be too thin) settles at once into the smallest crevice under the water, and if not stirred, it will not be made thin and rotten by it; or the plaster-batter may force the water before it until the latter escapes at the heel of the impression.

The impression once filled, the formation of the body is easy. For

deep models, the remaining plaster should be poured at once, that, while thin, it may form a smooth and level back. For shallow models the plaster must slightly stiffen, lest the weight of the impression should make it settle too much into the plaster on the table. The sponge is very useful in dressing up a model; it cuts more or less according to the state of the plaster. It may be used to trim vulcanite models directly after the spatula, or to give finish to other models after the use of the knife. But when plaster is fully hardened it has no effect.

Figs. 942 and 943 represent upper and lower models suitable for sand molding; the same may be used for dipping. Fig. 944 represents a shallow model in the molding flask, showing how the body of the die is formed by the zinc half of the flask. The same figure may be taken to represent the position of the thin model at the bottom of an iron tray, in the process of making the counter-die by Dr. Gunning's method.

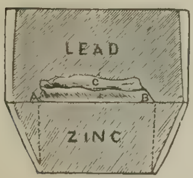


FIG. 944.

Difficulties arising from undercuts, on the outside of the upper ridge and on the inside of the lower, may be overcome: (1) by filling up the undercut with wax or plaster in all places where it is unnecessary or impracticable to carry the metallic plate; (2) by using a peculiarly-constructed flask for molding, such as the one invented by Dr. G. E. Hawes (Figs. 950–952); (3) by filling the undercut with movable pieces of plaster, technically known as "false cores." They should be so shaped as to admit of being drawn from the sand; at the same time they must have a decided angle, so as to mark distinctly the place in the sand for their replacement. A small nail or tack in the sand, above the core, will keep it in place while the metal is being poured. (4) By making a sectional model (Fig. 945), as suggested by Dr. A. Westcott. It may be made by filling the central third of the wax impression with the plaster, keeping it from the lateral thirds by a temporary use of clay or putty. This is removed and trimmed, leaving the back wider than the face (Fig. 945); then replaced in the impression and filled up on each side with plaster; the model is then removed, properly trimmed, and varnished.

Dr. Bean's method of making a model in two parts is equally applicable to making models in three parts, and is perhaps better than the foregoing. He thus described it: "To secure a division in the model itself, the best plan is to set up in the impression a septum of thin sheet lead, forming a vertical plane in the median line of the palate, and fitted somewhat to the inequalities of the impression. This plate should have two or three small projections struck up on one side, by

means of a small conical punch, and the opposite side has some cotton fiber attached with shellac, in the manner described for preparing impression trays. Fig. 946 represents the shape of this plate (one-half the size), and shows the side on which are the projections. Its proper position will be readily understood when applied to an impression of one of those deep palates now under consideration. The side having the projections is oiled, the cotton on the other side wet with water, and while filling up the impression, this plate is set up in the middle, along the median line, so that when the model is trimmed to proper size and shape, it may be carefully broken apart and placed together again in the same position."

Much time may be wasted in the effort to overcome difficulties of undercut in sand molding. The dexterous removal of shallow models will suffice for most cases of front undercut; and of all others, it may

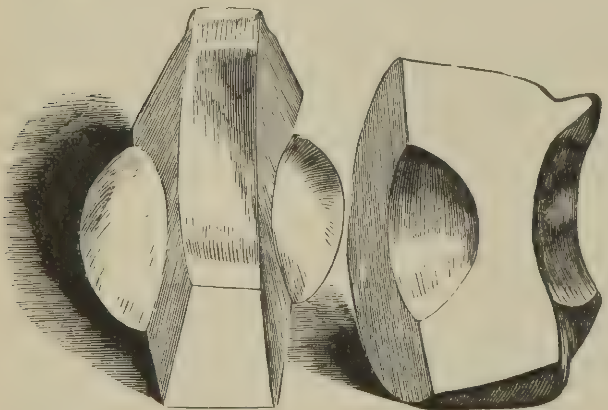


FIG. 945.

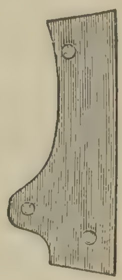


FIG. 946.

be said that no undercut on the die is of any service into which the plate cannot be swaged, or in removal from which the plate is apt to be bent.

Removing the impression is a fruitful source of vexation, because of the frequent breaking of prominent parts of the model and other annoying accidents. But these are in every case the result of haste, carelessness, or forgetfulness. First, the model must have time to harden; then the impression, if of wax or gutta-percha, must be thoroughly softened. The common practice of setting the model on the stove is bad; the smell of burning wax is often the first warning of a softening which has gone too far, injuring the model by the absorption of melted wax. It is far better to place it in water at 140° and 150° Fahrenheit, leaving it long enough for the entire mass of wax to

soften ; at this temperature the wax does not melt, yet is so soft that it cannot injure the most delicate point of the model. If over 150°, some portions may adhere to the model and give trouble in removing. Gutta-percha impressions must be thoroughly softened in water at 200°; if over this temperature, portions of gutta-percha are apt to adhere to the surface. In partial cases it is a good plan to first remove the tray, then turn up the edges of softened wax or gutta-percha, till it is free from the teeth, and then remove the entire mass.

Plaster impressions require a different treatment. If the tray is wholly or partly of wax or gutta-percha, these must first be softened and removed; a Britannia tray is loosened by light strokes of the plaster knife handle. The impression is then broken away piecemeal. Dipping it in hot water makes it rotten, and facilitates, at times, its removal. It is often necessary to cut nearly through the impression in places, in doing which the knife or graver must be held so as to guard against injury to the model beneath. Another safeguard is to coat the impression, before pouring, with oil colored by alkanet; or, better still, to tinge the plaster with which the impression is taken with vermilion or Brandon red ; it gives the dry plaster a faint pinkish tinge; does not, in this small proportion, injure its setting qualities; and it makes a very distinct contrast with the pure white of the model.

Few impressions can be used twice; those taken in wax or gutta-percha trays, never. Partial impressions of all kinds are necessarily sacrificed to the integrity of the first model. But plaster impressions, in a smooth Britannia tray, may, with proper care, be replaced in the tray, and used again so as to give a model quite equal to the first. Some of these will come from the model entire; but often it is necessary to cut a groove over the alveolus, and break off the outer rim in two or three sections.

Models may be partly trimmed before removing the impression, but it is always necessary afterward to trim the shoulder. Usually this is done by merely taking off the rough edges, following the outline of the edge of the impression ; but for striking up a plate with the outer edge turned up, a flange, or shoulder, about the fourth of an inch wide, is formed around the outside of the plaster model, where it is designed that the edge of the base plate shall terminate on the alveolar border. It may be shaped either in wax or plaster, and should stand off from the ridge at an angle of about 90° or 100°, the angle of the rim being completed with pliers after swaging. A plate swaged with such a rim is used in mounting gum or block teeth and in continuous gum work ; it is stronger than a simple plate, and is susceptible of a more beautiful finish. For a lower set of block teeth the edge of the plate may also

be turned up all the way round. An objection to a swaged rim is the occasional difficulty of determining just how far over the ridge the plate should extend; for any change is impossible without destroying the rim. Hence the more common practice, except in continuous gum work, is to solder a gold band or wire, after adaptation of the plate to the mouth, as hereafter explained.

The model, if it is to be used in sand molding, should have several coats of shellac or sandarach varnish applied with a small bristle brush, to give it a smooth, hard, and polished surface. This will protect it from injury by use, render it more pleasant to handle, and cause the sand to part easily from it. The gum shellac varnish may be prepared by dissolving five ounces of shellac in one quart of alcohol. In using this varnish on a damp impression, be careful not to apply a second coat until the first is hard, else it will cause the first to peel and injure the smoothness of the surface. Sandarach varnish is preferable to shellac, as it is harder; it is also more transparent, and, consequently, does not color the plaster. It may be made in the following manner: Take six ounces of gum-sandarach, one ounce of elemi; digest in one quart of alcohol, moderately warm, until dissolved; or the sandarach alone may be used. This is, perhaps, as good a varnish as can be used for plaster models. It is easily prepared, but the alcohol should be warmed in a sand bath or hot water, to prevent it from taking fire. To make the finest varnish, the sandarach should be of best quality, and washed in water before being put into the alcohol. Some, however, prefer a coating of charcoal dust or plumbago or powdered soapstone for sand models.

Models for dipping or pouring, or the fusible-metal process, should have no kind of varnish upon them. Vulcanite and other plastic work models may have a protecting coat of dilute soluble glass (nine parts water to one part of the glacial syrup); but if too much or too strong a solution is used, it will do more harm than good. No shellac or sandarach varnish should be applied to plaster models for either vulcanite or celluloid work.

For the preparation of the surface of the plaster model to overcome the difficulty resulting from a hard ridge or prominence in the center of the palatal portion, the reader is referred to page 846.

CHAPTER IX.

DIES AND COUNTER-DIES—SWAGING PLATES.

VARIOUS methods have been adopted for procuring metallic dies and counter-dies. The three following are all which the author deems it necessary to describe. The first of these consists in pouring melted metal into a mold or matrix, made in sand with the plaster model. By this means the die is formed, and the counter-die is obtained by pouring metal upon it. The second consists in making the counter die first, either by immersing the plaster model in metal or pouring metal upon it; the die is formed by pouring metal into this.

The third consists in pouring the metal for the metallic die directly into the impression. A very ingenious set of flasks for this purpose, the invention of Dr. F. Y. Clark, can be had at the dental depots. The same may be done, less conveniently, perhaps, with the usual Britannia trays and molding rings. Take a piece of copper or brass gauze, and fit into the tray before taking the impression. Set the impression, thus strengthened, into a batter (asbestos or sand three parts, plaster one part), poured into a narrow iron ring (sheet iron will answer); carefully work the batter around the edges of the impression; then place upon it the zinc-molding half of a Bailey flask (Fig. 947).


FIG. 947.

If the impression is thoroughly dried, the first metallic die will be perfect, no matter how much undercut there may be. A second or third may then be taken, more or less defective, but very useful for the first stages of the swaging process. Zinc is the metal used by Dr. Clark for the die. In this process the impression may be plaster or plaster and feldspar; but the investing batter should have only enough plaster to bind the asbestos or sand together. Dr. Clark uses a copper impression tray, which Prof. Austen's process dispenses with. The flask and impression must be perfectly dry, and heated nearly or quite up to the fusion point of the metal used.

The second method admits of three modifications: 1. The *fusible-metal* process; in which the model is surrounded with thick paper, and fusible metal in a semi-fluid state is dashed over it with a spoon, the model being cold, so as to rapidly chill the metal. While still warm, the paper is removed and the counter-die trimmed with a knife; for at this temperature it can be cut as readily as cheese. The counter-die, when cold, is then smoked or coated with whiting, surrounded with paper, and semifluid fusible metal dashed on it, to make the die.

This process is repeated until from two to six dies are made, according to the irregularity of the case. The model should be in a ring of nearly circular shape and cylindrical; it should also be at least half an inch larger than the alveolar ridge, that the counter-die may have sufficient metal to force up the plate.

2. The *dipping* process consists in pouring melted lead, type-metal, or pewter into a sheet- or cast-iron cup or box, three and a half or four inches in diameter and three or four inches deep, until it is more than half full; then, stirring the fluid mass with gradually increasing rapidity until it begins to granulate, quickly brush off the surface dross, and at once immerse the plaster model more or less deeply, as the palate is a deep or shallow one, and hold it there until the metal congeals. To prevent accident from air confined in the palatine arch, a small hole may be drilled through the plaster model. It is then removed, and the whole upper surface of the counter-die covered with a thin coating of whiting or lamp smoke, as before directed. After this has become perfectly dry, melted block tin, type metal, or soft solder, at a temperature so low that it will not char, or even discolor white paper, is poured in, until the cup is filled. If the counter-die is so deep that the die has not sufficient thickness, it may be deepened by placing on the freshly poured metal the zinc half of a Bailey flask, and continuing to pour; the metal in the two flasks will unite and form one die. When cold, the castings are removed from the iron cup, separated, and are then ready for use.

3. *Dr. Gunning's* method, called also the "pouring process," in which a very thin model (made of plaster two parts and sand or feldspar one part) is placed in the bottom of an iron box, three and a half to four inches in diameter and about two inches deep. It is fastened there by a thin layer of plaster and sand, then thoroughly dried by gradually raising box and all to the temperature of the melted metal, which is next poured in, and the box set in a shallow vessel of water to cool it rapidly from the outside. To delay the cooling in the center until the last moment, and to prevent contraction at that place, a very hot pointed iron, somewhat similar in shape and size to a tinner's soldering iron, is placed upon the center of the model before the metal is poured. When cold, this is removed and the conical space filled with metal. The counter-die is thus made of lead, alloyed with tin or type metal. The die is made by placing over this a stout wrought iron ring and pouring in fusible metal. Dr. Gunning uses from three to eight dies, according to the sharpness of the prominences of the model. The method gives, in his hands, very accurately fitting plates.

When metallic dies are to be obtained by the first method, molding

flasks and sand are required. Flasks may be of wood or iron. The molding box of wood should be about six inches square. This is to be filled with fine sand, such as is used by brass founders, in the following manner: The deep or shallow plaster model is placed on the molding table, exactly in the center of the box, with its face upward. Sand is then firmly packed around the sides of the model. Sand should then be sifted, covering the face of the model to the depth of half an inch, the box then filled, and the whole rammed with a firmness proportioned to the coarseness or dryness of the sand—damp or very fine or strong (*i. e.*, with large percentage of clay) sand not permitting so much compression as sand possessing the opposite qualities, because it would become too compact to permit the escape of the vapors formed during the process of pouring. But the finest sand, rich in clay and quite moist, may be used if it is dried before pouring. Sand mixed with olive or sweet oil possesses some advantages over that mixed with water, as it can be used a number of times without remixing, prevents the bubbling common to sand made too moist with water. The sand should never be burned by pouring on it very hot metal; hence it is better to stir the metal until it has cooled somewhat before pouring it into the mold. The metal should not be injured by overheating. Cooling the die suddenly in water renders it brittle.

The box is then turned over and gently tapped several times with some light instrument or hammer, for the purpose of starting or detaching it a little from the matrix, and then carefully removed. Great care is necessary that this tapping does not depress first one side and then the other; this would make the die too deep in the center, and perhaps cause the plate to rock. The model may be loosened laterally, by holding an excavator firmly upon the center of the die and tapping it on the side. If the model be composed of three pieces, the middle section is first removed, and afterward the two others. There are two ways of drawing the model: first, by screwing into it an excavator or gimlet, and carefully drawing it out; second, by throwing it out with a dexterous jerk of the matrix. The last is best; the excavator is apt to break through the center of the thin model, and the thick one falls out by its own weight better than it can be drawn. Fig. 948 represents the two ends of a double spatula, which will be found very useful in sand molding.

If the deep model is used, the matrix is now ready for pouring; but first remove all loose sand, and make a groove at the back part of the matrix to receive the first flow of the metal. If the thin model is used, a ring must be set upon the sand after the model is drawn, to give the additional size which the die requires to prevent cracking under the swaging-hammer.

The mold being prepared, the metal to be employed for the casting should be put into a tolerably thick wrought or cast-iron ladle and melted in a common fire or furnace. Mr. Fletcher has invented a very useful melting apparatus, which is also suitable for drying and boiling purposes. If brass is used, a blast furnace will be required to melt it; but if zinc, block-tin, or lead, a common fire will afford sufficient heat. As soon as the metal has become thoroughly melted it is poured

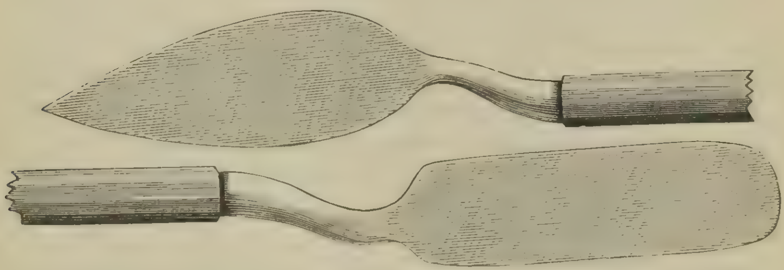


FIG. 948.

into the furrow formed in the sand, whence it will flow into the back part of the mold. It is necessary to convey the melted metal into the mold in this way to prevent the injury which the surface of the sand might sustain by pouring directly upon it.

There have been quite a number of molding flasks devised to supersede the wooden one just described or the common cart-wheel box, which was once much used. Some of these are worse than useless; others are very convenient, and have the advantage of requiring only

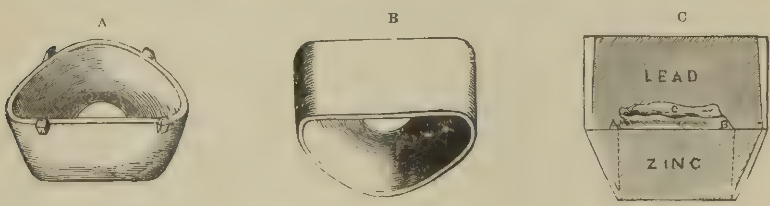


FIG. 949.

a small quantity of sand; also of permitting the sand to be dried, which cannot well be done in the wooden box. The simplest and perhaps best flask is that invented by Dr. E. N. Bailey. Fig. 949 represents the shape and working of this flask.

Half flask B is placed, joint-edge downward, over a thin model, and firmly packed with sand. It is then turned; the sand compressed around the edge of the model; then trimmed, so that the model may be easily drawn (a properly shaped model renders much sand trim-

ming unnecessary) ; the model is then lightly tapped and thrown out. All operations on the thin model must be conducted with great care, for it is easily displaced in its matrix, so as to destroy the accuracy of the latter. Next, pour zinc into the mold, and at once place on half flask A, and complete the pouring. When cool, remove the sand, invert the flask, with zinc die contained, and pour the lead (C) upon the zinc for the counter-die.

In cases of moderate undercut in front, the thin model can generally be drawn by a dexterous backward movement. But for a deeper undercut in front, also for those at the side, the molding flask of Dr. Hawes (Figs. 950, 951, 952) will be found useful. In Fig. 950 the lower section of the flask is slightly opened to show joints. In Fig. 952 the upper section. In Fig. 951 the lower section is closed and confined by a pin, with the plaster model placed in it.

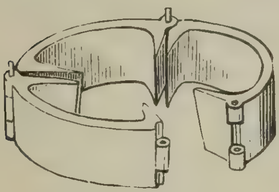


FIG. 950.

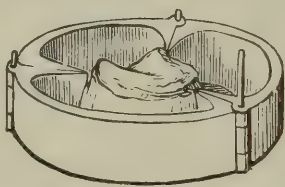


FIG. 951.

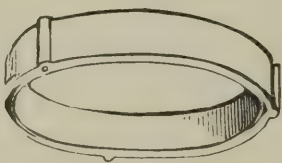


FIG. 952.

The manner of using is thus described by Dr. C. C. Allen : "If the model be considerably smaller than the space between the flanges projecting inward, small slips of paper may be placed in the joint, extending to the sides of the model, so as to part the sand when opening the flask for the removal of the pattern. The sand may now be packed around the model up to the most prominent part of the ridge. It should be finished smoothly around it, slightly descending toward the model, so as to form a thick edge of sand for the more perfect parting of the flask. The sand and face of the model must now be covered with dry pulverized charcoal, sifted evenly over the whole surface. When this is done, the upper section of the flask is placed over the lower and carefully filled with sand. It is then raised from the lower one, which may now be parted by removing the long pin, and the model gently taken away. When closed, and the two put

together again and inverted, it is ready to receive the melted metal." After the metal has cooled, it may be removed and turned over, so that the face of the die shall be upward, while the remainder is buried in the sand. Thus placed, it is encircled with the ring (Fig. 952) and the metal for the counter-die poured upon it.

The metals most commonly used, when metallic dies are made by sand molding, are zinc and lead. For many reasons these are, perhaps, the best metals for general use that can be employed. Zinc is the hardest metal that the dentist can conveniently melt. In case of deep or large arches, and for mouths where the mucous membrane is very hard, should its shrinkage prevent the close adaptation of the plate, a finishing die may be made of block tin, type metal, soft solder, or Babbitt metal (a patent alloy of copper, tin, and antimony, the best formula for which is Dr. Haskell's: copper, 1 part; antimony, 2 parts; tin, 8 parts), which last is nearly as hard as zinc and has decidedly less shrinkage. When a metal softer than zinc is used, several dies will be necessary to complete the swaging. As this Babbitt metal fuses at a lower temperature than lead, it is necessary to use a counter-die in which tin forms a part; Dr. Haskell therefore recommends the following formula: lead, 5 parts; tin, 1 part. The die should be coated with whiting solution before pouring the counter-die.

The late Prof. Austen, by careful experiment, found that an average-size zinc die, measuring two inches transversely, contracts $\frac{27}{1000}$ of an inch from outside to outside of the alveolar ridge, being equivalent in thickness to three ordinary book leaves. He remarks: "In the first case (upper jaw), the plate would 'bind,' and if the ridge were covered by an unyielding mucous membrane, it would prevent accuracy of adaptation. In the second case (upper jaw), the plate would have too much 'play,' and consequently lack stability. Again, in a moderately deep arch, say half an inch in depth, the shrinkage between the level of the ridge and the floor of the palate will be nearly $\frac{7}{1000}$—rather more than one leaf. In the deepest arches this shrinkage may give trouble, except where the ridge is soft, and then it becomes a positive advantage. In the shallower cases, it is not of much moment, as there is no mouth so hard as not to yield the $\frac{1}{1000}$ or $\frac{2}{1000}$ of an inch."

A counter-die should be soft. When but one metal is used, lead is decidedly the best metal for this purpose; tin may also be used if the die is made of zinc, but tin counter-dies are only employed for the final swaging, and after the use of lead counter-dies. It is desirable, if practicable, that the metal last poured (in sand molding, this is the counter-die) should melt at a lower temperature than the other. In this respect zinc and lead are admirably suited—zinc melting at 770° and lead at 600°. Tin melting at 440° might be supposed, in this

respect, better than lead; but such is not the fact, owing to the tendency of tin and zinc to form alloys, while lead and zinc have no such affinity.

The requisites for a die are non-shrinkage, hardness, strength, smoothness of surface, and fusibility at a low temperature. The Babbitt metal after the formula before given furnishes such qualities.

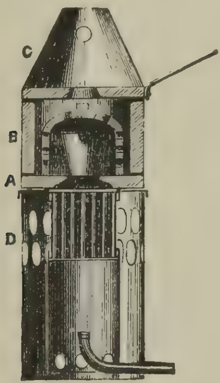


FIG. 953.

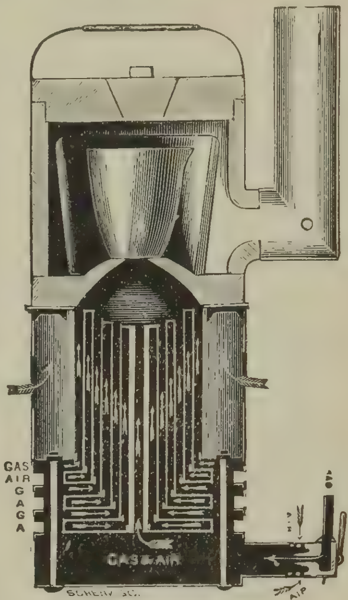


FIG. 954.

Fig. 953 represents an excellent gas furnace for melting and refining gold and other precious metals and for melting zinc, lead, etc., of the baser metals. Fig. 954 represents a sectional diagram of the same furnace. In using plumbago crucibles, etc., they must be heated slowly when first employed. Mr. Fletcher's small gas furnace, which is well adapted for melting the metals

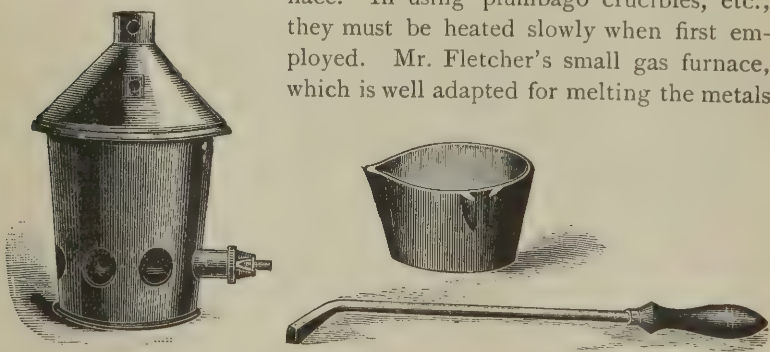


FIG. 955.

employed for dies and counter-dies, is represented by Fig. 955.

In a paper on metallic dies, published in the fourth volume of the *American Journal of Dental Science*, Prof. Austen gives, as the

result of careful experiment, the following tabular view of the fusible alloys—zinc being introduced for the purpose of comparison :—

	Melting Point.	Contractility.	Hardness.	Brittleness.
1. Zinc, ...	770°	.01366	.018	5
2. Lead, 2 ; tin, 1, ...	440°	.00633	.050	3
3. Lead, 1 ; tin, 2, ...	340°	.00500	.040	3
4. Lead, 2 ; tin, 3 ; antimony, 1, .	420°	.00433	.026	7
5. Lead, 5 ; tin, 6 ; antimony, 1, .	320°	.00566	.035	6
6. Lead, 5 ; tin, 6 ; antimony, 1 ; bismuth, 3, ...	300°	.00266	.030	9
7. Lead, 1 ; tin, 1 ; bismuth, 1, . .	250°	.00066	.042	7
8. Lead, 5 ; tin, 3 ; bismuth, 8, . .	200°	.00200	.045	8
9. Lead, 2 ; tin, 1 ; bismuth, 3, . .	200°	.00133	.048	7

The last column contains an approximate estimate of the relative brittleness of the samples given. As in the other columns, the low numbers represent the metals, so far as this property is concerned, most desirable. Those marked below 5 are malleable metals ; those above 5 are brittle ; zinc, marked 5, separates these two classes, and belongs to one or the other according to the way in which it is managed.

In all cases of melting it is a safe rule to pour the metals at the lowest temperature at which they will flow. It is prudent, also, to coat the metal on which other metal is poured with a mixture of alcohol and whiting, to prevent all chance of adhesion. One more very important caution in the melting of zinc and lead is invariably to use separate ladles ; for any lead left from a previous melting flows from the ladle with the last portions of the zinc, and, being heavier (in the proportion of 11 to 7) and more fluid, falls at once to the bottom of the matrix, making the alveolar ridge more or less of a soft metal, thus totally destroying its usefulness.

The elastic vapor generated by the contact of the water in the sand with the hot metal sometimes collects under or rises through the metal, and renders the casting more or less imperfect. This may be prevented : 1, by drying the sand ; 2, by using coarse or loosely-packed sand and avoiding too much moisture ; 3, by mixing the sand with oil instead of water. The slightest moisture on one metal, previous to the pouring of another metal upon it, will make the latter imperfect. The following method has been suggested to overcome this difficulty : "To prevent imperfections or bubbles in the palatal portion of metallic dies, it is not necessary to dry the mold after it is formed, or to use more than ordinary precaution as to the heat of the

metal. The best result is obtained when the plaster model is quite thick and the mold consequently deep. This is then tipped forward, raising the back part or condyles to the highest point possible, pouring the metal in at the front slowly, and lowering the mold at the same time until the palatal portion is covered and the mold filled to the top." The use of oiled sand, however, as before remarked, will prevent imperfections by bubbling on the palatal portion of the die.

In making metallic dies for partial cases, about three-fourths of the crowns of the teeth should be cut from the plaster model before using it for molding. The plate can be fitted more easily and perfectly than can be done when the teeth remain on the plaster model and zinc die; for, in the former case, the plate need not be cut to fit the teeth until it has been swaged; while in the latter this must be done first; consequently, in striking it up, it will be drawn to a greater or less distance away from them. There is also danger of splitting the plate, in swaging it into the spaces between the teeth, if these are left on the metallic die. Half or partial counter-dies adapted to the palatal portion of the die only, and not extending quite to the ridge, are useful in the case of a deep arch, and prevent the plate from tearing during the swaging process.

We shall conclude the section on metallic dies by giving some practical suggestions by Prof. Austen on the properties and uses of the metals and alloys employed for this purpose.

Many of the properties of these metals, though most interesting, are not practically useful to the dentist; but there are some points, for which he usually refers to his memorandum book, that should be printed on the page of his memory. The following tables present two properties of certain metals in a form convenient for memorizing; although not absolutely accurate, they are quite enough so for use in the dental laboratory:—

Order of Fusibility.		*Order of Specific Gravity.*	
Copper,	2000°	Lead,	11.5
Antimony,	900°	Bismuth,	10.
Zinc,	770°	Cadmium,	8.5
Lead,	600°	Tin,	7.5
Bismuth,	500°	Zinc,	7.
Tin and cadmium,	440°	Antimony,	6.5

In the fusibility table, copper is given to show how unsuited it is for laboratory use. Remembering that 900° is *red heat*, the next four numbers may be easily memorized. In the specific gravity table, copper 9. and iron 8. are omitted, so as to present the table in a form easily remembered.

The only pure metals suitable for a die are zinc and tin; for a counter-die, tin and lead. When one metal is used for either die or counter-die, zinc makes the best die and lead the best counter-die. Copper is too hard to fuse; antimony and bismuth are too brittle; cadmium is too expensive. All other metals used in swaging are alloys.

Zinc and lead are valuable because: They are so unlike that they are not easily mistaken for each other—a very common error when alloys are used. They have no such disposition to alloy as zinc and tin or tin and lead have. Zinc is so hard, one die will suffice for many cases; three are sufficient for the most difficult. The brittleness may be corrected by the size of the die. Its shrinkage is often a decided advantage; and in some cases, where it makes the plate bind on the alveolus, the contraction may be anticipated by coating these parts on the model with one or two layers of very thin plaster. Zinc, after repeated use, becomes defective, hence, a supply of new metal should always be kept.

No metal used alone equals lead as a counter-die. Its weight and softness are in its favor for this purpose. A counter-die cannot be too large or heavy; convenience, of course, limits its size. A difficult plate cannot be swaged with a small counter-die, unless the work is nearly completed by partial counters, hammers, etc., before using it. As regards softness, the greater the disparity between die and counter, the less will be the change in the die by the act of swaging. The plate is forced by the counter into the depressions of a die, not so much by its hardness, as by its *vis inertia* under the swaging blows. The little disparity in the hardness of the two dies is one serious objection to the use of the second class of operations. It is a common practice to use several counters, and perhaps only one die. One die may in a few cases suffice; two are better, and often three; but good swaging never demands more than one counter-die, where that is properly made.

With zinc, lead, and one fusible alloy (tin and bismuth, equal parts, or Babbitt's metal) all swaging operations may be completed when the dies are made by sand molding or by pouring zinc into the impression. But since many prefer other methods of making dies, it is important to understand the subject of alloys. Experiment is here the only basis of knowledge, for no *a priori* reasoning could deduce the singular changes caused, and new properties developed, by alloying.

The alloy of two brittle metals is always brittle, and a brittle metal usually imparts this property to a tough one nearly in proportion to its percentage. But that two tough metals can make a brittle alloy is remarkable. Malleable copper, with half its weight of brittle zinc, gives hard brass, which, though less tough than copper, is not brittle.

But malleable copper, with malleable tin in the same proportions, makes speculum metal—the most brittle alloy known. A similar instance is that of lead, the softest of metals, which will, in minute quantities, make gold, the most malleable of all metals, very brittle.

Another remarkable property of all alloys is fusibility. Alloys fuse below the average melting point of their constituents. Ternary compounds exhibit this more strikingly than binary. The following table, in illustration of this property, will be found practically useful to the dentist in the selection of alloys:—

ALLOYS OF BISMUTH, LEAD AND TIN.

	BISMUTH, 500°.	LEAD, 600°.	TIN, 440°.	FAHRENHEIT.
1		10	1	540°
2		5	1	510°
3		2	1	440°
4		1	1	370°
5		2	3	335°
6		1	2	340°
7		1	5	380°
8	1	4	4	320°
9	1	2	2	290°
10	1	1	1	260°
11.	2	1	1	220°

It will be noticed that two pounds of lead do not make one pound of tin harder to melt, whilst a half pound reduces its fusion point 100°. Also, Nos. 6 and 7, though containing more tin than No. 5, are harder to melt. Again, a pound of bismuth added to alloy No. 4 reduces its melting point 110°. No. 11 and all alloys containing much bismuth are brittle. The alloys of this table vary somewhat in hardness, but all are harder than tin.

The "alloying metals" of the dental laboratory are copper, antimony, and bismuth. Copper gives hardness to zinc and tin, and is sometimes combined with alloys of the two. But the high fusion point of copper renders it less useful to the dentist than the other two metals. The alloy of copper, antimony, and tin (Babbitt metal) is perhaps the only one of practical interest. Its advantage over zinc, in being less liable to contract, is perhaps set off by the tendency of most alloys to change their composition by frequent melting; and the danger of mixing different alloys, from the absence of such distinctive marks as separate zinc and lead.

Antimony is a more valuable alloying metal. It hardens tin, but its chief use in the laboratory is to harden lead, making type metal. Small types composed of lead 4, antimony 1, are too brittle; and large

types, lead 6, antimony 1, are scarcely fit for laboratory use. In the proportion of 9 to 1, antimony corrects the excessive contraction of lead and hardens it, yet leaves it tough, so as to resist the blows of swaging. It is suitable only for counter-dies.

The very common opinion that antimony causes lead to expand on cooling is erroneous. The alloy has a slight expansion at the moment of solidification; but after that it obeys the universal law of all metals, and contracts as it cools. Actual contraction depends upon the ratio of contraction and the fusion point; thus, lead contracts more than zinc because its high ratio of contraction more than compensates its lower fusion point.

Another common error is that a zinc die poured very hot is smaller than if poured at its fusion point. Of course, contraction begins the moment cooling begins; but so long as the metal is fluid it necessarily fills the matrix. and contraction causes simply subsidence of the metal. No die begins to leave the walls of the matrix until it solidifies; hence, the amount of contraction is the same in all cases. Very hot zinc copies minutely the sand surface, and thus has not that bright, smooth appearance of cooler zinc, which sets before penetrating the sand interstices; but both are equally good. Another difference is in the greater depth in the cavity on the back of the hot-poured die. But this is not as objectionable as many think; no good mechanic strikes directly upon the die, but upon some ovoid or conical piece of metal covering the cavity in the back.

Bismuth is perhaps the most valuable, to the dentist, of the three alloying metals. Antimony gives hardness, but not much fusibility; bismuth gives fusibility, but no great hardness. The table above given shows the marked effect of this metal. It is seldom used as a binary alloy, because its fluxing qualities are more fully brought out in ternary combination; also because of its expensiveness, and its tendency to impart brittleness. Type metal is rendered more fusible by the addition of .05 per cent. of bismuth.

Bismuth, antimony, and zinc are readily distinguished—bismuth by its great weight and characteristic pinkish color; antimony by its peculiar crystallization and its excessive brittleness. But the alloys of these metals with tin and lead have such a general resemblance, that they must, with much care and system, be kept apart in properly labeled boxes; otherwise, if more than one alloy is used, the annoyance caused by using one for another will more than offset their utility; in fact, such negligence defeats their usefulness.

But the formula of Dr. L. P. Haskell for preparing the Babbitt metal is superior to all others for use as a die: tin, 8 parts; copper, 1 part; antimony, 2 parts. For a counter-die for such a die: lead,

5 parts; tin, 1 part. He claims that such a Babbitt alloy for the die cannot be excelled.

Dr. C. J. Essig recommends zinc for a counter-die for swaging a plate of platinum-gold or iridium-platinum; and also that such a counter-die is of especial service in partial cases where a number of teeth remain. For difficult swaging he recommends three sets of dies and counter-dies, the most imperfect of the dies being furnished with a lead counter-die, to be first used, and the next in quality to be used with a zinc counter-die, and the nearest perfect of all with a lead counter-die as a finishing die.

SWAGING.

A die and counter-die having been obtained, a piece of tin foil or sheet lead is adapted to the former, and the dimensions of the plate marked upon it. Paper is sometimes used for this purpose, but is not so good as thin sheet lead or heavy tin foil. The pattern thus made is cut out, flattened, and laid upon the gold plate, and its outline marked upon it. The outline of the plate may be marked on the plaster model and the pattern cut in conformity therewith. The margins of the plate for the upper jaw should extend as high as possible, and especially over the position of the canine teeth, in order to restore the expression, which is greatly changed by the loss of the natural teeth at such points; back of the canine teeth the margin of the plate should be lowered so as to avoid the attachment of the muscles and to allow the latter free motion or action. The plate should also embrace the maxillary tuberosities in order to obtain stability, and the margins at such points may extend higher than over the bicuspids and first molars. The plate should be cut a little too large, to allow for trimming and any accidental slipping upon the die. In partial cases the pattern should be carried partly, or fully, over the excised teeth, and no attempt made to fit it accurately around the necks of the teeth until the swaging is nearly or quite completed. With a pair of strong shears the portion of plate thus marked is cut out. Fig. 956 represents a pair of shears, with long and conveniently-shaped handles. The blades of some shears are curved laterally; but this form is not desirable. A fine watch spring saw, Fig. 613 (p. 679), should be used for curves which the straight shears will not cut; curved shears may also be used for such a purpose; for very short curves—around teeth, for instance—a pair of cutting forceps will be found useful.

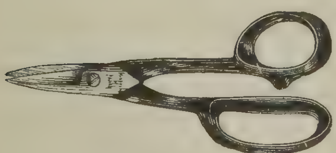


FIG. 956.

Figs. 957, 958, 959 represent nippers or cutting forceps for cutting out plate.

Cutting plates to shape before swaging is, however, not only unnecessary, but is in many cases a positive disadvantage. Swaging the

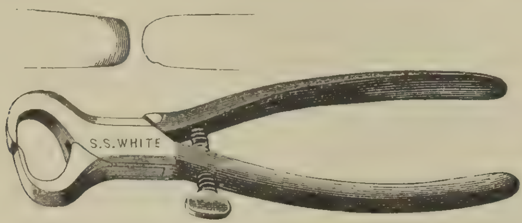


FIG. 957.

square plate is greatly preferable in the lower jaw, since it permits working from the center outward. And in both upper and lower plates, the two triangular pieces outside the ridge help to prevent plaiting, or doubling of the plate. Purchased plates are ordered to

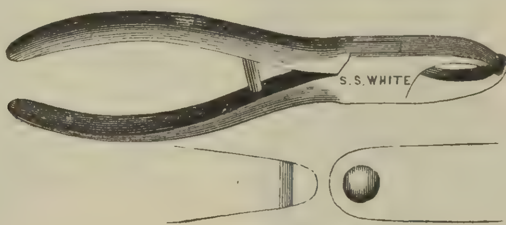


FIG. 958.

pattern on the score of economy; but the difference is trifling, since good plate scrap has nearly the same value as the original plate, and every careful operator separates his plate scrap from his solder scrap


FIG. 959.

and filings. After swaging is nearly completed, with partial counters and hammers, the square plate may be quickly trimmed to shape by means of a jeweler's saw.

The plate must be well annealed, and partially fitted by wooden, horn, or leaden hammers, to that part of the die inside the ridge. There is no better hammer for this purpose than lead; but, of course, the plate must be thoroughly cleansed of all trace of the lead before annealing. The swaging is continued by the use of *partial* counter-dies; these are made by placing a rim of clay or putty around the ridge and back part of the metallic die, and pouring on it fusible metal. In this way, the plate should be perfectly fitted so far as the ridge. Then, clamping the plate between the die and the partial counter, the edge is to be gradually carried over the top and outside of the ridge with hammers and small wooden or ivory stakes. The

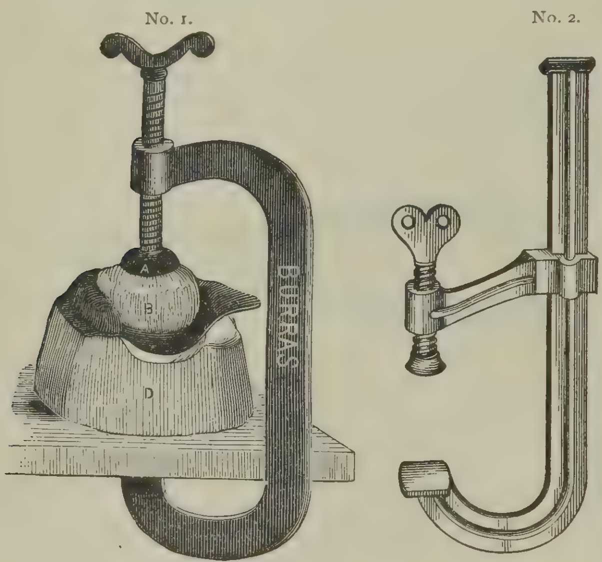


FIG. 960.

plate may be clamped in a vise, or by means of a string passing over the die and under the foot; but a much more convenient method is found in the use of Dr. T. H. Burras's clamps, Fig. 960. Of the two forms here given, the sliding arm (No. 2) is preferable to the long screw (No. 1). The application of the clamp is so plainly shown in No. 1 that any description is unnecessary.

It is the practice of some to cut out V-shaped pieces from the front or back part of the plate, to prevent the plaiting of the metal. This is very bad practice and is never called for, if due care is used in swaging and the metal is of proper fineness. To avoid plaits or folds, anneal often, and in deep arches carry the plate down very gradually;

also take care in such cases that the plate be thick, to allow for stretching or drawing. In swaging over the ridge, it is a very common mistake to hammer down the outside before fully striking up (with hammer and stakes) the parts nearest the partial counter-die. Always make it a rule, in carrying the plate over the ridge, to swage from the center outward, and carry the plate "home" as you proceed. In deep arches, irregular alveolar ridges, and in prominent lower ridges swaging must be done slowly and with great care.

In the use of forceps for bending lower plates (Fig. 961), care must be taken not to bruise the metal, as will any steel or hard metal instruments. There is no shape of arch or of plate which, by the above simple process, cannot be perfectly fitted with a 20-carat plate. The elaborate forms of a window cornice or a jelly mold should teach any dentist how poor a mechanic he is when he complains of the difficulty of swaging so highly malleable a metal as gold into and over the

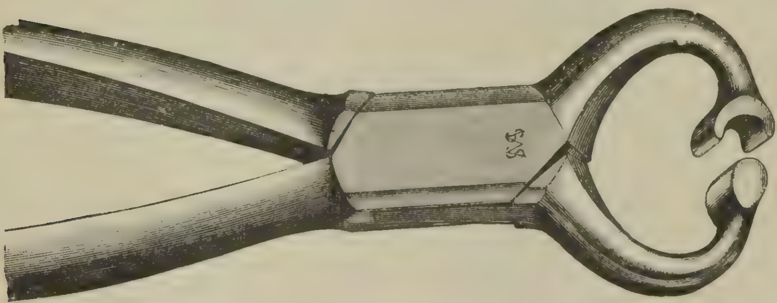


FIG. 961.

irregularities of the mouth. And when, to save his skill, he pleads want of time, he exposes a graver deficiency—dishonesty.

The fitting of the plate being thus almost completed by hammers and partial counters, it should be trimmed to its exact shape, and then placed between a fresh die and the full counter die, and carried "home" by several firm blows of the hammer, given directly over the center of the die. The hammer should not weigh more than three pounds, with a handle about a foot long. It is a great mistake to use a very heavy or a very long-handled hammer. The striking-block may be an anvil, or a large wooden block set in sand or on a cushion, and the base of the counter-die must rest steadily upon it. Dr. Haskell describes a movable swaging-block to be kept under the bench as follows: "Eight inches wide at the top, and eleven inches at the bottom, just high enough to pass under the bench. Make it of pine with a plank bottom, to which attach heavy casters, a handle on

one side, and a pocket for the hammer. Have an iron 6-inch cube cast, and, filling the box nearly full of sawdust, place the iron cube in it so it will extend two inches above the box." It greatly facilitates swaging, and makes one independent of any striking block, to have a very thick and heavy lead counter. As there is always a hollow in the back of a zinc die, a conical piece of iron, steel, or other hard metal should be placed upon it to centralize the blow of the hammer. An eggshell filled with plaster is useful as a model for making, at the time of molding the die, several zinc blocks for this purpose. To a disregard of these precautions is due much of the difficulty so often complained of in the tilting or rocking of plates and dies.

Throughout the entire process of swaging the plate must be frequently annealed. It may be suddenly cooled after all except the final annealing, when the cooling must be very gradual, so as to avoid warping or springing. The malleability of gold plate will permit a great deal of swaging without annealing ; yet the neglect of this simple operation is unsafe. One broken or cracked plate gives more trouble than the annealing of a dozen. The plate, after final swaging, must be taken from the counter very carefully, to avoid change of shape. Thin paper in the counter-die makes removal easier ; it is also easier when only one counter is used. Too much swaging gives the plate a loose fit.

When block-tin, lead, or fusible metal dies or counter-dies are used in swaging the plate, any portion of these metals which may adhere to it should be removed before annealing, as their fusion upon its surface alloys them with the gold, and will render it brittle and impair its ductility, or else eat holes in the plate at the spot where the particles of baser metal form an alloy, fusible at the annealing heat. This is done either by mechanical or chemical means. If acid is used, it should be dilute nitric, since sulphuric will not dissolve lead ; but be very careful that the nitric acid contains no hydrochloric, else the plate will be acted upon. A copper or lead acid-dish may be employed, many preferring one made of thick sheet lead. Oiling the dies will also prevent the base metal from adhering to the plate, as any particles of the former can be readily wiped off.

The plate, in the case of a full upper denture, should be so outlined as to have the highest portion of the rim over the cuspids, curving downward back of such points to the maxillary tuberosities, where it again should ascend so as to extend over these prominences. (Fig. 962) Space should also be made for the frenum of the lip by cutting away the edge or rim for its reception. In the case of a full lower denture, the bending pliers may be used first, and its outline should be such that it does not interfere with the muscles and loose integuments.

For a very flat ridge, the lower plate should be double to give strength, and for partial lower dentures it is better to double the plate where strength is required; strength is also secured by the plate, in such cases, extending above the necks of the teeth, in some instances half way, where the attachment of the muscles would otherwise necessitate a very narrow plate. Each piece of a double plate should be swaged separately, and the two parts then soldered together, wire clasps being

FIG. 962.

used to hold them in position during the soldering process. If the denture is to be retained by clasps, the plate, either upper or lower, should extend at least one-fourth of an inch beyond the clasped tooth in order to secure stability. In soldering the two parts of a double plate, the edges of one should slightly overlap the other so as to facilitate the process.

Figs. 963 and 964 represent the general forms of upper and lower

FIG. 963.

FIG. 964.

plates after the swaging process is completed. In the upper plate is represented the proper size and position of a vacuum cavity, according to area of mouth, whenever it may be thought proper to use one. The question of the cavity will be elsewhere discussed.

If on trial of the plate in the mouth it does not fit properly, the operator must proceed to ascertain the cause of failure. And, first, whether it is temporary or permanent. A plate which falls because it

rocks over a hard palate will never improve; if because it fails to go fully into the palate it may daily improve, and ultimately adhere with great firmness. Most plates made soon after extraction fit badly until the alveolar prominences are pressed down by wear. Some very hard mouths will not retain the plate until it has been worn for a time, especially if the mouth is very flat. Deep arches, or uniformly soft mouths, should retain the plate firmly from the first.

The use of pliers, except for bending the edge into some alveolar undercut, is an evidence of bad work. The back margin of upper plates, so often adjusted in this way, is much better fitted by scraping the model at the place where the plate should bind; this should be done to a depth proportioned to the softness of the membrane.

Much judgment is demanded in deciding upon the necessity for a new plate. The impression may have been badly taken, or with a material not adapted to the mouth. The dies may have been carelessly made, or the swaging imperfectly done. Trial of the plate is essential to ascertain all these points, that the articulation, soldering, etc., may not be so much additional labor in vain.

In fitting a plate, the operator should see that its posterior margin, especially at the center, is so closely adapted as to exclude air. Dr. Haskell recommends wetting the plate before placing it in the mouth, and then by a "pumping process" watching for the escape of air bubbles. At the same time the plate should not press so hard at the center of its posterior margin as to irritate the mucous membrane. To determine whether a lower plate infringes upon the muscles and lower integuments, the patient may be directed to raise the tongue, which will dislodge the plate if it so interferes by its depth. The lip can also be raised in front to determine if the plate extends too deep at that point.

The different forms of plates, full and partial, will hereafter be considered. They are retained in the mouth by clasps or stays; by the adhesion of contact or by the vacuum cavity, the retaining force being atmospheric pressure; by the elastic spring of the wings of the plate; by spiral springs. These will be taken up in a subsequent chapter and their relative merits discussed. We pass now to the step which, in swaged work, comes next in order to the fitting of the plate—the means for securing its exact relation to the natural teeth, or, in double sets, its relation to the opposing plate. These processes come under the technical head of Articulation.

CHAPTER X.

ARTICULATION.

THE term Articulation, as used in Dental Mechanics, comprehends several distinct operations, implied in the use of the terms (1) Articulating impressions; (2) Articulating plates; (3) Articulating models.

In many partial tests it is best, after fitting the swaged plate to the mouth, to take a wax impression with the plate *in situ*. This gives the precise relation of the plate to the adjacent teeth; and upon application of a model of the lower jaw, it gives the relation of the plate to the antagonist teeth. This and all other impressions of the *relation* of plates to the teeth or to each other in the mouth we call articulating impressions.

A base plate becomes an articulating plate when the articulating rim is attached which has the impress of its opposite rim or teeth. In swaged work it is the gold plate itself; in plastic work it is some temporary plate of tin, lead, or gutta percha.

The articulating models make up what is technically called an "Articulator," of which there are many forms; all, however, comprehended under three varieties: (*a*) Those wholly of plaster poured into the articulating plates. (*b*) Those in which the model portion is poured into the articulating plates, but the back or hinged portion is metallic. (*c*) Those in which the original models are set into the articulating plates, and some complicated metallic articulator adjusted to them. Each of these classes have special advantages adapting them to various exigencies of practice.

Whenever, in partial cases, there are three points of contact sufficiently apart to give firm antagonism, Prof. Austen's plan was to take an impression of the lower teeth; this gives a model which antagonizes perfectly with the upper model, and makes the articulator without further trouble. This plan, specially applicable to vulcanite work, is adapted to swaged work by taking the articulating impression described in the second paragraph of this chapter. Such articulators require no backward extension or hinge, because the articulation is determined by the articulating cusps of the teeth.

In partial cases, where there are only one or two points of antagonism, and where, consequently, the opposition of the corresponding teeth would be uncertain, the necessity exists for some third point of support. This is best given by a backward extension of the model, so as to permit motion of the two halves of the articulator, somewhat resembling that of the natural jaws, though many partial cases do not require such an extension. In putting this wax rim on the

plate it is better in all cases to trim it, as is done for full upper sets; but where there are remaining teeth the antagonism of these determines the proper closure of the mouth, and this is not essential. The plate and adherent wax are placed in the mouth; the patient is then requested to close the mouth naturally, imbedding the teeth of the lower jaw in the wax. While the mouth is thus closed, the wax on the outside of the teeth and alveolar ridge is pressed closely against them.

This done, the plate and wax impression are carefully removed, filled with plaster, and placed on a piece of wet paper, with the wax downward. The upper side of the plate is then oiled. As the plaster stiffens it may be applied until it is raised half an inch above the plate, and extended back of it on the paper an inch and a half or two inches. As soon as the plaster has set, its edges may be neatly trimmed; and at the back of the surface next the paper a deep transverse or T-shaped groove should be cut to serve as a model for the formation of a corresponding ridge on the half model with which this is to antagonize. This grooved surface must be coated with oil or soap water or varnish, or covered with a layer of tin foil or thin paper. Then partly fill the space inclosed by the wax rim with clay, putty, or wet paper, and pour on plaster to form the other half model. In running plaster into the wax impressions of the teeth, be very careful to avoid air bubbles and flaws, and do not oil the wax. After the plaster has set it may be trimmed as before directed.

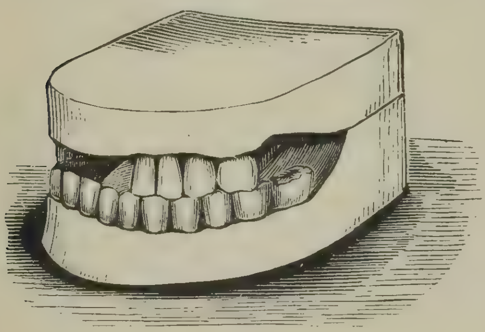


FIG. 965.

Another and often more convenient method is to take a strip of sheet lead one and a-half inches wide, and bend it to the required outline of the articulator. Pour this partly full of plaster, and set the plate, previously filled with plaster, upon it. Cut the grooves as before described, and pour the other half of the articulator. The lead rim saves much manipulation and trimming, which, in the other case, the plaster requires. When the half last made has become sufficiently hardened, the two pieces may be separated, after softening the wax in warm water, and the wax carefully removed. The model is then varnished, for greater comfort in handling, and when put together may present an appearance exhibited in Fig. 965.

The artist has failed in this, and in other designs of the plaster articulator, to represent the tapering shape which it is best to give to the back half of the models, for greater convenience of holding them while adapting the teeth. The fault of many plaster articulators is that they are too large and clumsily shaped. In any given case the proper distance of the groove or hinge is the distance from the patient's external auditory meatus to the line of the front teeth or alveolar ridge. The width and thickness of the articulator must vary with the size or depth of the mouth, avoiding any excess of plaster not necessary to give requisite strength.

For a full upper set, or where two or more remaining molars have no antagonism, it is a very common practice to place on the plate a roll of wax sufficiently large to receive the imprint of the lower teeth, and to prevent these from closing too far by the insertion of a piece of wood buried in the wax and projecting at the median line. The closure is better arrested by two lumps of sealing wax attached opposite the bicuspids, and trimmed to the required length before putting on the wax. But the articulation ought to determine other points besides the single one of space. Hence the antagonizing plate should be made by adjusting a rim of wax corresponding in width to the length proposed for the artificial teeth, and trimming it until all the teeth in the lower jaw touch it at the same instant. Instead of wax, a rim of gutta-percha may be used to represent the required length and external fullness of the teeth. When this is satisfactorily adjusted, a small rim of soft wax is placed upon the wax or gutta-percha, and the mouth closed as naturally as possible until the teeth touch the latter. The gutta-percha can be readily trimmed with a sharp knife. Rims thus shaped give opportunity to ascertain, by the effect on the expression of the lips, etc., exactly what length and fullness of tooth suits the particular case. Gutta-percha is better than wax in arresting the closure of the teeth, and is decidedly best for the temporary articulating plates of plastic work; but the latter is more easily attached to a gold plate and is more easily trimmed. By making the wax cold, or by imbedding a small block of wood opposite the bicuspids on each side, with the grain of the wood running transversely, for easy trimming, the wax rim offers a firm resistance.

There is a tendency on the part of the patient to close the mouth to one side, and nearly always to project the jaw too far forward; it is impossible to close it behind the natural articulation. The simplest method for regulating this is to keep the body erect and throw the head backward, so as to make as tense as possible the throat muscles, which thus act as a bridle, and almost compel a correct closure of the mouth. It may also be done by careful observation of repeated

closures made by the patient while sitting in an erect natural position. The operator must avoid impressing upon his patient the necessity for an easy natural closure ; such directions invariably defeat their object. Of course, these trials are to be made before attaching the soft wax which receives the impress upon the final closure. A vertical median line, traced on the wax, is of service in observing the articulation and in the subsequent adjustment of the artificial teeth. Fig. 966 represents such a rim with its original fullness cut away.

For a double set of artificial teeth the following method of articulation is often adopted. After having accurately fitted both plates, a rim of soft beeswax is placed between them, about an inch and a quarter in width. A piece of wood, exactly corresponding in width to the proposed length of the upper and lower central incisors, is passed through the wax between the plates at the median line; or, still better, one piece on each side between the bicuspid part of the plates. The whole is now placed in the mouth, and each plate accurately adjusted to the alveolar border. The patient is then directed to close the mouth until the plates are brought in contact with the edges of the interposed piece of wood. This done, the plate, wax, and wood are together removed from the mouth.

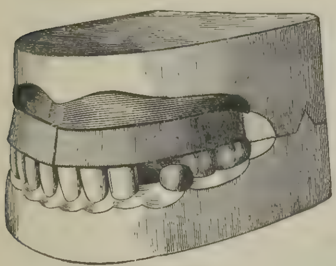


FIG. 966.

But a far better method consists in placing a rim of wax or gutta-percha on each plate, giving the length, outline, and fullness respectively designed for the teeth of each jaw. The two plates are put in the mouth, and the jaws are carefully closed ; if the rims of wax touch at any one point sooner than another, the plates are removed and the wax trimmed ; this operation is repeated until the two rims of wax meet all the way round at the same instant, and give the proper contour to the cheeks and lips. The median line is then marked, and the final closure of the mouth made with the utmost care, so that there shall be no lateral or forward deviation. The exact position being secured, the lower jaw is to be held with the left hand, while with the right some six or eight oblique indentations are made with a wax-knife across the line of contact between the two rims. Some fasten them together by a warm wax-knife or by pins or by small slips of brass plate warmed and forced into the wax. The pieces are removed jointly or separately from the mouth ; if separately, they can, by the aid of these marks, be accurately readjusted.

From these articulating plates a plaster articulator (Fig. 967) is

made substantially in the manner described for a partial case. If the precaution is taken to fill the space within the wax rims and between the plates with paper pulp, it is not material which half is filled first. Usually the lower-jaw model will be thickest, and in this, made first, it is best to cut the grooves. Fig. 967 represents a plaster articulator with the plates removed, in which figure, from neglect of this point, the thin upper half is much weakened by the V-shaped cut.

Dr. J. G. Templeton suggests the following method of properly articulating a set of teeth: "Having to make a full upper set of teeth, we will suppose the impression and model to have been made in the usual way. Take modeling composition, and make of it a trial plate (a gutta-percha plate will answer also). It should accurately fit the model. Melt a little wax around on the ridge, then press a roll of softened wax on that, and trim to what is supposed to be a sufficient

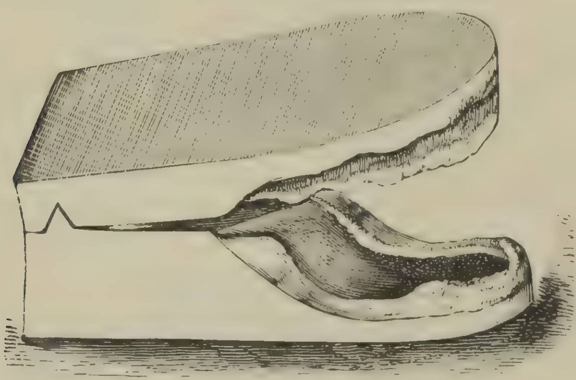


FIG. 967.

length, then try in the mouth and carefully trim the lower edge to the proper length for the teeth; if it is not, either add or cut away until the wax represents the proper length of the teeth. This wax should be so cut on its articulating surface that all the lower natural teeth will strike it at the same time when tried in the mouth. Now remove and soften the articulating wax surface just a little over the flame, then replace in the mouth, and do not let patient bite into it until you have the head drawn well back so as to put the anterior muscles of the neck on a stretch; then have the patient bite a little on the wax just to get an impression of the cusps and cutting-edges of all the lower teeth. Next take an accurate impression of the lower teeth, from which make a plaster model, which will fit into the slight impressions of the teeth made in the bite taken, and then place the whole on any good articulator which can be set to maintain the relative positions. Remove the

bite, and you are ready to set the teeth to a correct articulation, and if all has been carefully done the teeth will come together properly without any subsequent grinding.

"For a double set (upper and lower) make trial plates of modeling composition to take the bite on, putting a piece of rather stiff wire in the lower one to stiffen it. Wax the ridges as previously prescribed. Place a roll of softened wax on the upper trial plate, place the lower trial plate in the mouth, being careful to see that it is in its proper place, and hold it there while putting in the upper plate with the wax on it. Do not allow the patient to bite until the head is drawn back as far as you can get it; then tell the patient to bite, and keep the jaws closed until with one finger the wax has been well pressed on to the trial plates. Mark the center or median line on the wax. Have patient close the lips, and then take a small, straight instrument and mark on the wax the height of the lower lip. This mark should extend from one angle of the mouth to the other; you then have the line of fissure or line of lip-closure, in other words, the height of the lower lip and length of the upper, to serve as a guide in making the wax models. After thus taking the bite, place each of the models in the bite so obtained, and fasten in any good articulator; then prepare corresponding wax models, which should be tried in the mouth to verify their correctness. They should come together in the mouth the same as on the articulator, and if they do not they should be made to do so before proceeding further. Take pains to be satisfied that the wax models are correctly adjusted and give a natural expression to all the facial features, observing that the lower third of the wax model is in proper proportion or length with the upper two-thirds, and be sure to produce the proper fullness over the region of the upper cuspids to give as near as possible the natural contour. Then take the upper and lower plaster models off the metal articulator, and make a plaster extension to the back part of upper model, on which place the wax models, which have been marked while in the mouth so that they can be put in the same position out of the mouth. The lower plaster model is placed in position, and a plaster extension added to fit to that of the upper plaster model. After separating these, the lower wax model is placed on the lower plaster model, and the inside space filled with wet paper, and plaster is poured over all to make the lower articulating plate, to which the lower teeth are to be set. Next place the upper model in position, and set the upper teeth to the lower ones which have just been set to the lower articulating plate, and when ready for flasking, if for vulcanite plates, saw off articulating ends. Always set the lower teeth first."

Partly to save plaster, but chiefly to permit modification of the

articulation where inaccuracy is suspected, quite a number of metallic articulators have been recommended. One of the first contrived for this purpose was by Dr. Thomas Evans, of Paris, and made of heavy brass wire.

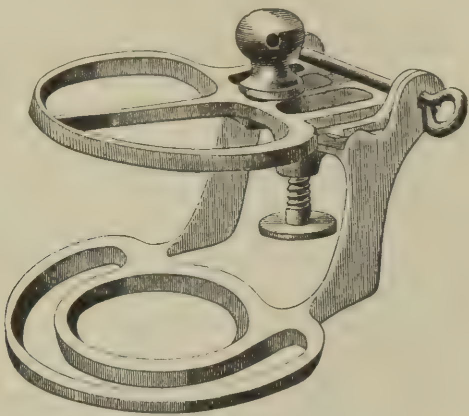


FIG. 968.

Fig. 968 represents a very convenient form of metallic articulator. But in using this and every similar contrivance the operator should remember that facility of changing the articulation, after the guiding

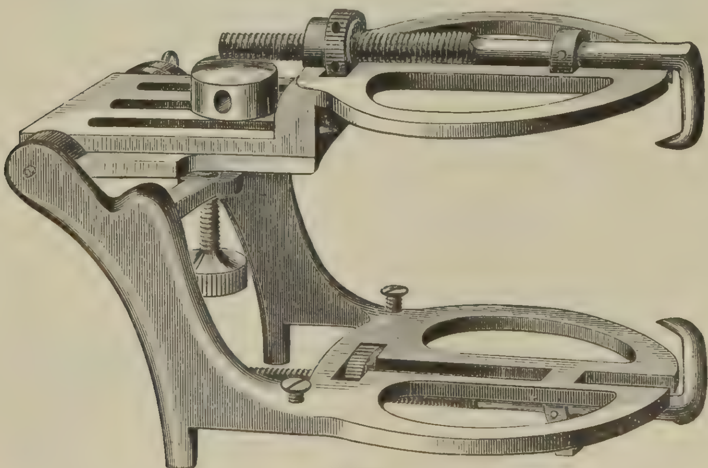


FIG. 969.

wax rims are removed, is a very questionable advantage. It tempts to carelessness in articulating. Moreover, if the width of space or other relation of the parts is such as leads to suspicion of inaccuracy, any change of articulation is, at best, a sort of random guess-work. The

most certain correction of surmised error is, undoubtedly, to take the articulation anew. Hence some prefer the old-fashioned plaster articulator, with its unaccommodating fixedness, that neither offers a premium on carelessness, nor puts the careful workman at the mercy of some loose joint or screw.

There is another class of articulators more complicated than the above, which are very useful in those cases where the original models are used, instead of special models cast in the articulating plates. Fig. 969 represents an articulator devised by Dr. J. B. McPherson, the valuable feature of which is the clamping fixture for holding the plaster model. The danger of breaking frail models in removing them from the articulator is overcome, as they can be removed by simply loosening the clamp. It has also a lateral movement resembling that of the jaw.

Dr. W. Storer How suggests the use of soft yet sufficiently stiff and thin metal plates for securing an exact tooth-length and a correct articulation, which he terms "true bite-plates." His description of these plates and method of using is as follows:*—

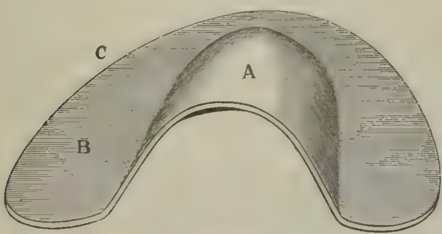


Fig. 970.

"In Fig. 970 is seen an upper bite-plate of suitable thin metal, having a palatal portion A, a plane portion B, and a contoured edge or border C. When a full upper denture is contemplated, the bite is at once taken by placing on the bite-plate, Fig. 970, a sufficient quantity of warmed beeeswax to secure a completely good impression, and at the same time afford material for modeling the labial and buccal surfaces in a suitable manner to produce the proper facial expression.

"The bite-plate here exhibits its novel and useful functions in enabling the dentist to readily lengthen or shorten the bite, and also adapt the bite-plane B to the lip-line, as well as to the occluding lower teeth. When this has been carefully done and the mass removed from the mouth, the appearance will approximate that of Fig. 971. If the bite then requires an increase of length, the bite-plate is

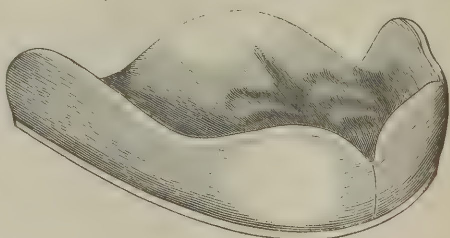


Fig. 971.

* *Dental Cosmos.*

held a moment over the Bunsen flame, when it will fall on a paper napkin held in the hand. It is then covered with a thin sheet of wax, replaced on the modeled wax, trimmed with the wax-knife along the contour border C, again put in the mouth, and conformably remodeled and readjusted. The quickly transmitted heat of the metal bite-plate permits facile changes in occlusive adaptation and contour, without disturbance of the fit of the impression portion of the wax, an advantage of real consequence and value.

"If upon further study it is desired to shorten the bite, the mass is removed from the mouth, the plate quickly warmed over the Bunsen flame, all replaced in the mouth, and the patient instructed to close the teeth firmly on the bite-plane, which, while accurately maintaining the plane of the occluding teeth to which it has been conformed, will at the same time cause the softer wax immediately in contact with the plate to gradually yield until the bite becomes suitably shortened.

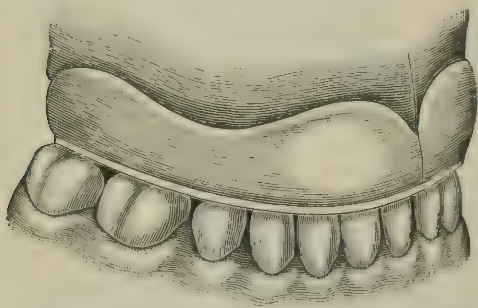


FIG. 972.

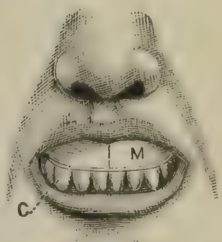


FIG. 973.

"In this connection it is important to note the functional difference of this metal bite plane from the common wax plane, which yields and is indented by any considerable pressure of the occluding teeth; whereas, in the present instance, so soon as the wax has cooled to a slight stiffness, the patient is directed to press the teeth hard on the bite plate (see Fig. 972), and the result is a bite-gauge identical in length with that which the finished denture will have under the ordinary pressure of the closed jaws. Many of the usual disappointing discrepancies between the common soft wax bite-gauges and the resulting defectively articulating dentures may now be avoided.

"The smooth and hard surface of the bite plane B fixes a constant and firm limit to the bite-length while allowing the utmost freedom of lower-jaw movement in occlusion during the adjusting and modeling processes to secure a natural oral and facial expression, with a proper lip line as indicated in Fig. 973. This having been accomplished, a

roll of warmed wax is placed on the under side of the bite-plate, which is replaced in the mouth, and the patient, while the previous process was going on, having been instructed and practiced in the correct manner of closing the jaw, the head being thrown back to bring the

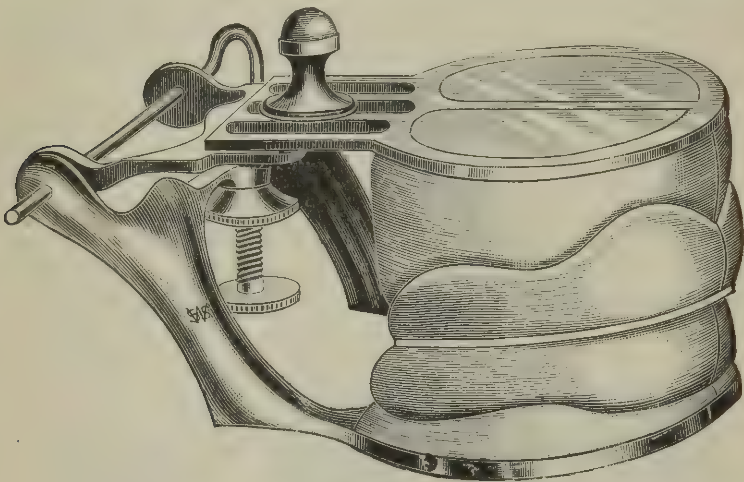


FIG. 974.

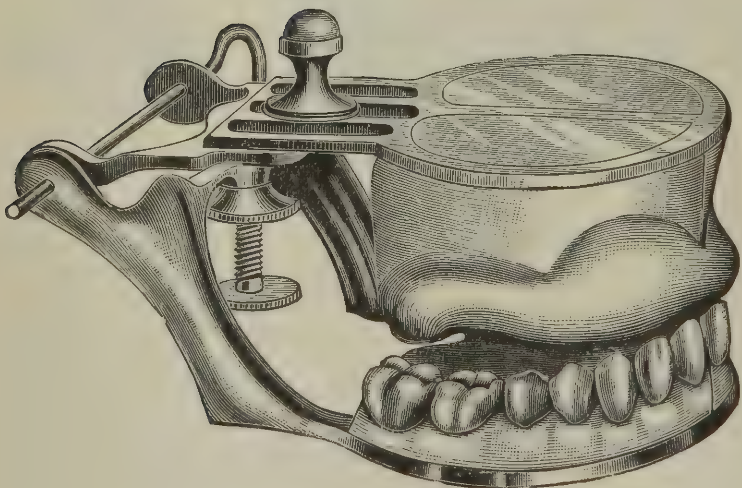


FIG. 975.

face horizontal and the jaw held as far back as possible, the teeth are pressed through the wax on to the bite-plate, and kept there while with the finger the labial and buccal portions of the soft wax are pressed in upon the natural teeth. The mass is then carefully removed from the

mouth and kept in safe readiness for transfer to the plaster model when obtained from the plaster impression, and it is unnecessary to dwell upon the advantages of securing a certainly correct bite at the time of the sitting secured for taking the plaster impression. Fig. 974 shows a bite thus taken and transferred to the model set in an articulator, and Fig. 975 represents the correct bite so obtained. This novel bite-plate provides for the taking of a very short bite, as shown in Fig. 975. In fact, the bite-plane B may rest directly upon the gums, and the under teeth strike the plate, yet the rigidity of the metal plate is such that the wax impression and modeling will not warp in the adjusting, shaping, and removing manipulations; whereas, by the old mere wax methods, a trustworthy very short bite is impracticable.

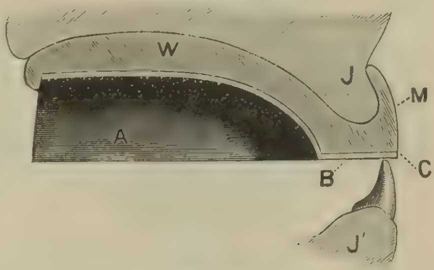


FIG. 976.

" Fig. 976 exhibits a median line section exemplifying the relations between the bite-plate A, B, C, the wax W, the modeling M, the upper jaw J, the lower jaw J', and the occluding lower teeth. Obviously, by simply first warming the bite-plate and then while in the mouth sliding it suitably forward, the contour modeling may be done to produce a result like that of the median line section, Fig. 977. In any given case the bite-plate border C can be easily cut or filed to suitably modify its contour to the desired configuration of the modeling, although it is best to have at hand several sizes of the bite-plate to use without delay for adaptation.

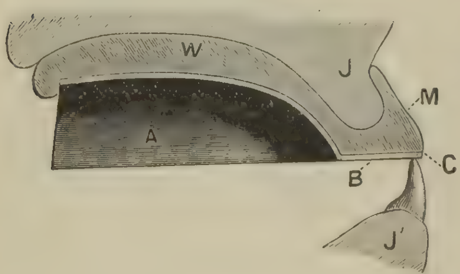


FIG. 977.

" By cutting away the wax W to expose the upper anterior gum G and ridge-crest from cuspid-place to cuspid-place, as shown in Fig. 978, the space between the bite-plane border C and the ridge-crest may be accurately gauged to determine the availability of artificial teeth having cross-pin, or up-and-down-pin bite length; it being a matter of importance at the outset to decide the question of permissible bite-

space between the gum crest and the down-pin border of the teeth-backs. The overbite or lap of the upper oral teeth over the incisive edges of the lower teeth may then be provided for by means of some softened wax on the under side of the bite-plane, modeling some wax over the anterior gum and edges of the lower teeth, as shown in Fig. 979.

"Bite impressions for partial dentures, however irregular the jaw surfaces or occlusive dispositions, can be most conveniently and correctly produced by means of the modified bite-plates herein shown and

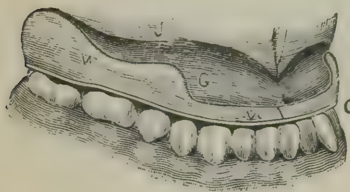


FIG. 978.

FIG. 979.

described. In some instances modeling compound, plaster, or moldine may be advantageously employed instead of wax.

"For partial upper dentures, sections of the bite-plate are with plate-nippers cut out, as at EE, Fig. 980, and the bite taken in the way previously described.

"The lower bite-plate, Fig. 981, is of like character with that of Fig. 970, the lingual portion D being designed to approximate the

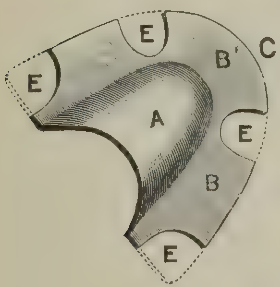


FIG. 980.

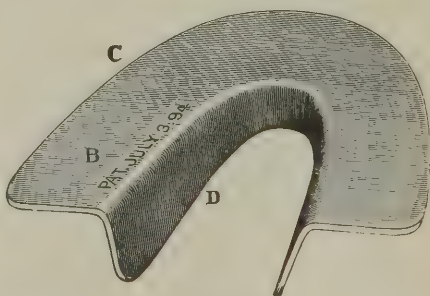


FIG. 981.

lingual conformation of the lower jaw, while the bite-plane B and contour border C have the bite-taking functions of the upper bite-plate. For partial lower dentures, sections may be cut out, as at EEF, Fig. 982, to permit the passage of the remaining natural teeth through the bite-plate, the intermediate planes of which can be shaped to conform to any plane of the occluding upper tooth or teeth.

"When either jaw is a very flat one, it is best to take first on the bite-

plate a good impression in wax, and then with a spoon spatula scoop out about an eighth of an inch deep over the surface of the impression, smear over it some rather thick mixed plaster, and take another complete impression. This, when allowed to get quite hard and suitably trimmed at its borders, may be often replaced, and readily retained in the mouth during the modeling and adjusting process requisite in obtaining the bite by the methods already described. In fact, this is the preferable procedure for bite-taking in the greater number of full-denture cases, since the plaster contact with the jaw is unvarying and retentive, while the bite-plate is adjustably movable on the intermediate modelable wax. There is, furthermore, the certainty that the plaster bite impression will fit the plaster model; in fact, it may sometimes supersede the plaster impression if found in some particulars the better. Thick-mixed plaster may be piled on the

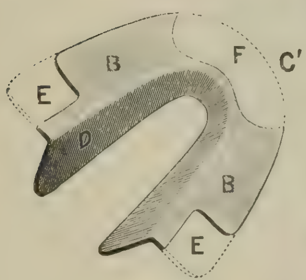


FIG. 982.

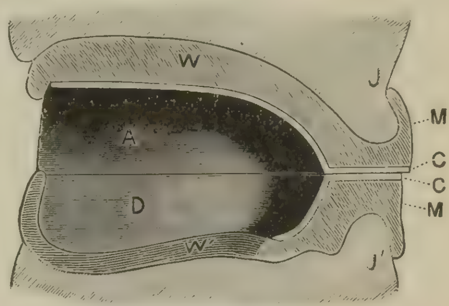


FIG. 983.

under surface of the bite-plane, and the occluding surfaces of the under teeth be perfectly copied for reproduction in fusible metal if desired.

"If the maxillary vault is a very low one, an upper bite-plate with its plane B resting on a flat block may be struck with a hammer on its arch A, Fig. 970, to suitably depress it to conform to the low vault. To suit a narrow high vault, set the buccal edge on a block or anvil and strike it with a hammer on the opposite edge to contract the wings and raise the arch A.

"In taking the bite for a full denture, the upper and lower bite-plates are used as already described, and the facility with which the modeling, contouring, lip-line, and relative upper and lower teeth lengths may be determined will agreeably surprise experienced prosthetists accustomed to the old wax-model methods. The upper and lower metal bite-planes, during the process of adjustment, perfectly maintain the bite length, yet slide freely upon each other during the mas-

ticatory movements of the jaw requisite in repeated trials to determine the correctness of the modeling and the bite-lengths. When that has been satisfactorily accomplished, the patient is instructed to properly close the jaws and hold them firmly closed while the median line mark is made, and the lips on either side held apart while the usual cross-lines are scratched over the modeling and the two bite-plate edges somewhere near the molar regions on both sides.

"Both models are then removed, the bite-planes dried, slightly warmed, placed upon each other so that the median line and scratched marks shall exactly coincide and be held so, while with a stick of melted hard wax the inside edges of the bite-planes are stuck fast to each other. The correctness of the bite may be verified by replacing the united bite-plates in the mouth, distending the lips and cheeks with the forefinger to free them from entanglement with the plates, and making careful renewed observations to be sure that the bite is correct. The median line section, Fig. 983, shows such a bite.

"In the duplex bite-plate, Fig. 984, the two plates, Figs. 970 and 980, are made as one; and with a full understanding of the processes previously described, it may be in like manner used to take the bite for a full upper, or full upper and lower denture, as the case may be, Fig. 974 serving as an example of the taken bite in either case.

"The duplex bite-plate has an occasional supplemental use for taking simultaneous impressions of the teeth in both jaws for regulating purposes; when it is desired, for instance, to make a vulcanite or cast-metal plate, a portion of which is to cap the molars or other teeth. In such a case the bite-plane is to be cut away to allow the passage of the anterior teeth, leaving such parts of the bite-plane as may be required to rest upon the teeth which are to be capped. The wax on the upper and under side of the remaining portions of the bite-plane will insure in the articulator models a representation of the occluding surfaces in their exact relations to each other, and separated by the desired thickness of the vulcanite caps of the regulating fixture.

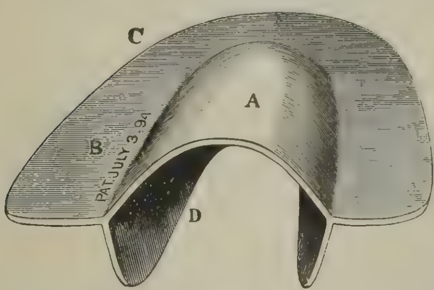


FIG. 984.

"In some instances, as when the vault is very high, the central part of the palatal portion A is slit and bent wide open, or with plate nippers suitably cut to allow the pressing up of the wax by the forefinger, to get a good impression of the deep vault.

"These bite-plates provide for, and emphasis is laid upon the importance of procuring, a complete and perfect impression, which will fit the plaster cast taken from the plaster impression and thus insure the correctness of the bite as reproduced on the articulator. (See Fig. 975.) In some instances modeling composition is used instead of wax. In every case the tendency to redundancy of labial and buccal material in the modeling is to be thoughtfully avoided, as may well be done since the good palatal fit will serve to retain the plate even when the labial part of the maxillary ridge is not covered by the modeled wax.

"It is best to first take the bite, and follow with the impression, which is usually taken in plaster and attended with more or less discomfort to the patient.

"Not the least of the notable excellences of the new bite-plate is the

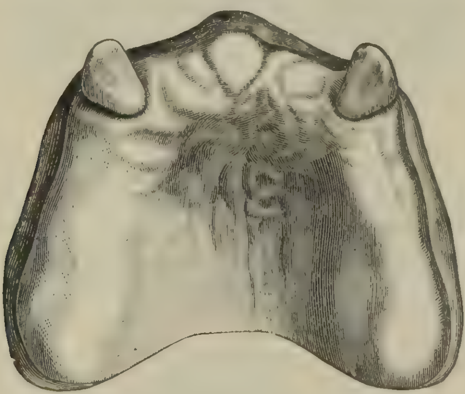


FIG. 985.

certainty that after the modeling has been done (see Figs. 972 and 973), the patient will bite through the soft under wax until the teeth strike and are stopped by the bite-plane, thus invariably and accurately gauging the teeth-length. Indeed, both the means and the methods are submitted in the confidence that time and practice will insure their general approval and adoption by the profession."

A further series of bite-plate exemplifications following the above, and relating to the adaptation of the bite-plate to partial dentures, are as follows:—

"Take, for instance, a case like that of Fig. 985, the superior cuspids only remaining. A sheet of thick tin foil, or of pattern tin, is to be cut to the outline of an upper bite-plate (Fig. 970), placed in the mouth, and with the forefinger rubbed on to the gum ridge and around the cuspids to show their relative positions. This rude pattern laid

on an upper bite-plate will indicate the points to be cut out with plate nippers, as at EE, Fig. 980. The bite-plane B may be sheared to shape, and the bite-plate by repeated trials in the mouth be quickly prepared to receive the wax for obtaining the preliminary bite-gauge as shown in Fig. 986. This, when removed from the mouth, will

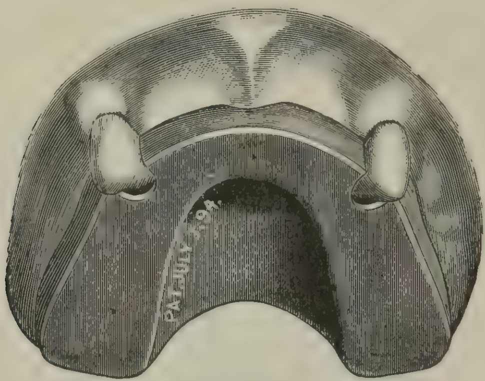


FIG. 986.

appear as seen in Fig. 987. When the additional wax for modeling and contour has been supplied, the case will present the appearance illustrated in Fig. 988, the median-line mark shown being a transference from that of the plaster models after the bite had been taken (as described on page 886) and placed on the articulator as in

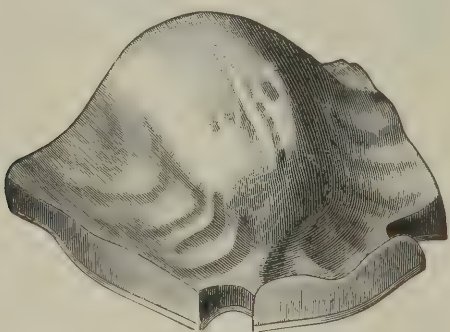


FIG. 987.

Fig. 974. Another instance is given in Fig. 989. Here the pattern-plate procedure is the same as above described, the bite-plate being readily fitted so that a piece of the bite-plane B, Fig. 980, shall enter every space that is to be occupied by an artificial tooth or teeth. There is no risk of overestimating the value of this adjunct of the

partial-denture process which results in an accurate bite ready for transfer to the model when obtained from the succeeding plaster impression.

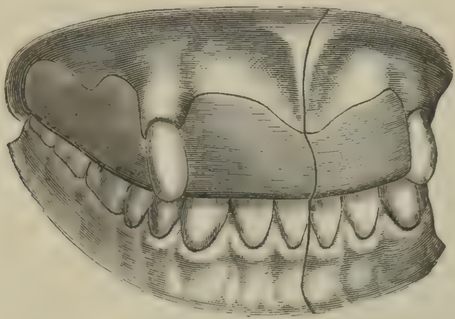


FIG. 988

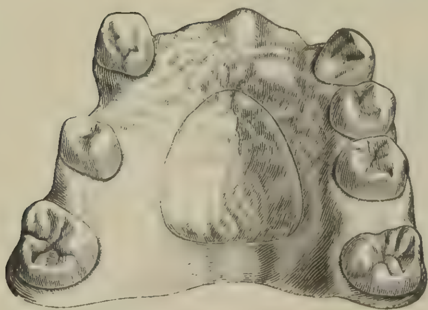


FIG. 989.

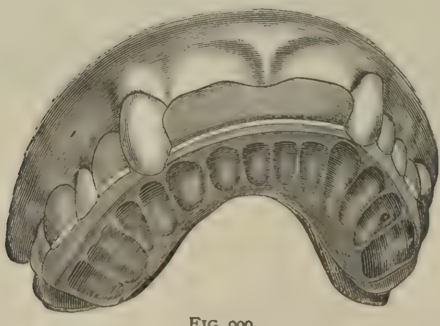


FIG. 990.

"Fig. 990 shows the taken bite with the labial and buccal portions of the under wax cut away to illustrate a defect in the common process of bite taking, not in fact manifest in the present instance, because the cuspids and other teeth compel a correct closure that is evidenced

by the thin films of wax at the points of occlusion contact seen on removing the bite, which is proven to be accurate when completed by the addition of wax over the labial and buccal surfaces of the lower teeth and a transference to the impression model on the articulator, the result being such as shown in Fig. 991.

"The common defect just referred to is the massing of too much wax on the under side of the trial plate, or bite-plate, and the consequent sliding forward of the lower front teeth as the inclined planes of their lingual surfaces are forced into the deep mass of wax, somewhat as is observable in the case illustrated by Fig. 990, and is made further obvious by Fig. 992. There is no practical need for a bite impression of the lingual surfaces of the lower teeth below the point P, Fig. 992, while on the other hand there is a serious reinforcement of the natural tendency to lower jaw protrusion in the act of desired bite-closure when the wax is massed as above mentioned. The new bite-plate permits the use of merely sufficient wax, as in Fig. 993, to reproduce the cutting-edges and cusps of the teeth without any aid to

FIG. 991.

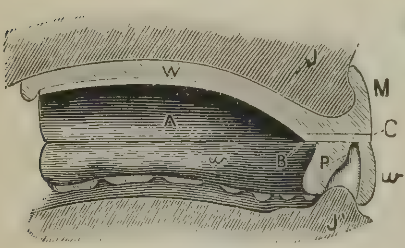


FIG. 992.

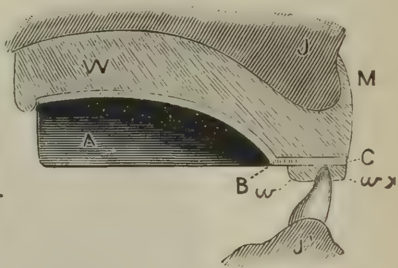


FIG. 993.

the protrusive tendency whatever. While the teeth remain closed for coronal bite reproduction, additional wax may be pressed on to the labial and buccal surfaces of the lower teeth to produce as perfect a representation as is shown in Fig. 991.

"It is hoped that the foregoing illustrations and descriptions will suffice as intimations of the manifold adaptation of the several bite-plate modifications to meet any and every case arising in practice, and

as affording ready means for the obtaining a correct bite prior to the taking of the usual plaster or modeling-composition impression, yet at the same sitting.

"The bite-plate method, while at the outset reasonably requiring the expenditure of some time and study, is still an economizer of both time and labor, inasmuch as it enables the dentist to meet the patient at the second sitting with a complete denture. In any case he may be ready with a trial-plate on which the teeth shall have been arranged and articulated so naturally that but slight alterations will probably be necessary. Especially will this be the case if instead of wax, as at *w*, Fig. 993, moldine shall have been used, and fusible metal poured in the coronal impressions to insure sharply-defined and non-abrasive cusps for accurate articulation."

Dr. W. G. A. Bonwill, who has devoted much time to the study of the geometric and mechanical laws of articulation, and devised an anatomical articulator (Fig. 994) in accordance therewith, treats this subject as follows:—

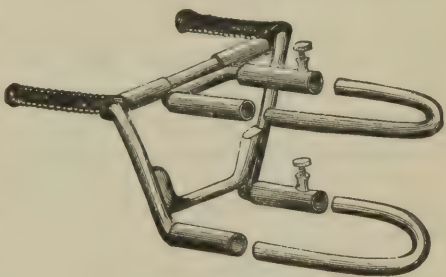


FIG. 994.

"We find from 28 to 32 teeth in each jaw, arranged in such a manner that no two strike directly against each other, but antagonizing in such a manner as to prevent the whole denture from becoming very irregular, which would be the case if striking one against another. By this arrangement, when one tooth is lost, the regularity of the arch is not interfered with. As necessary as this is in nature, it is not positively necessary to follow it in artificial work, although for the sake of harmony it should be done.

"It will be found in 95 per cent. of cases that the upper teeth project over the lower, and the depth of overbite varies as the depth of the cusps of the bicuspids are deep or shallow; and the ramus will be found to come upward and backward in relative proportion to the length of the cusps and the overbite.

"One point of very great importance has not been laid down in general or special anatomy—the peculiar tripod arrangement of the lower jaw, forming an equilateral triangle.

"From the center of one condyloid process to the other, four (4) inches is about the average; and it will be found that from this same center of the condyloid process to the median line at the point where the inferior centrals touch at the cutting edge is also four (4)

inches. It is strange it should have been overlooked; but it only shows, when studied in a geometrical and mechanical sense, the great wisdom in our formation. It varies slightly, but never more than one-fourth of an inch, which would make but a trifling difference in describing the arc of a circle. You will perceive that in setting your artificial teeth a one-fourth inch, the radius of the circle would not materially alter the articulation. Without such an arrangement the teeth would have to be flat on their grinding surfaces to admit of lateral movement. Besides, you would not have the beautiful and wise curvature at the ramus for equalizing the force applied to the teeth in all directions.

"Imagine the human jaw jointed at the pharynx, or as you see in the ordinary brass articulators. Do you suppose that there would be any greater wisdom displayed in such hinging or articulating a part destined to such varying motions and powerful wrenching force? No! We must see the true use or function of the jaw and the teeth, and the food destined for us, and how it should be comminuted; there is no chance work about it! There is law and order pervading every part; the jaw forms a perfect triangle for the purpose of bringing into contact the largest amount of grinding surface of the bicuspids and molars, and at the same time to have the incisors all come into action during these lateral movements.

"You will also find that from the cuspids the bicuspids and molars run in nearly a straight line instead of a curved one back toward the condyloid process, enabling them to keep the largest amount of surface always presented for mastication. Another thing which has never been explained by anatomists or naturalists is the law of the normal relation of the upper to the lower incisors. The normal jaw should overjet and also have a corresponding underbite. Without such a law the incisors would lose largely their functions, that of incising on the principle of a pair of scissors. Where the incisors strike directly upon each other the power to cut off food is very much lessened. The length of bicuspids and molars proves the law.

"Another unobserved fact where law is expressed, where there is an overbite and underbite, just in proportion to their depth will be the length of the cusps of the cuspids, bicuspids, and molars. By drawing two lines from T to F, Fig. 1001, or T to *a* and *e*, Fig. 995, we have the lengths of the cusps of the bicuspids, *b*, in the upper and *c* in the lower, and also *d*, the second upper molar. The depth of the underbite is one-eighth of an inch from the cutting edge of the inferior central incisor *e* to that of the superior central incisor *a*. Did the teeth extend as far back as A, A, there would be flat surfaces at those points. But in articulating artificial teeth, when the superior

second molar is reached, its distal cusp has to be raised from line T *e* to T *a*, Fig. 995, to allow the molar teeth on the opposite side, not in mastication, to touch, for merely balancing the plate, as Fig. 998, M, N, otherwise the second molars would be of no use in lateral movement, nor would the first molars. This curvature at the ramus (see Figs. 999 and 1000) commences at the first molar, although it shows itself slightly in the bicuspids. Practically it need commence at the first upper molar. This curve, then, will always be proportioned by the underbite at *a*, *e*. The length of the cusps on bicuspids will never be more than an eighth of an inch normally; the groove deeper than that would cut the palatal cusp off and make of it a cuspid. It would in reality be cut in twain. *This is another unobserved fact. It always has been and will be found in the archtype of human jaws.* So that when you see a first superior bicuspid, it can very well be told from the length of the cusps whether the jaw from

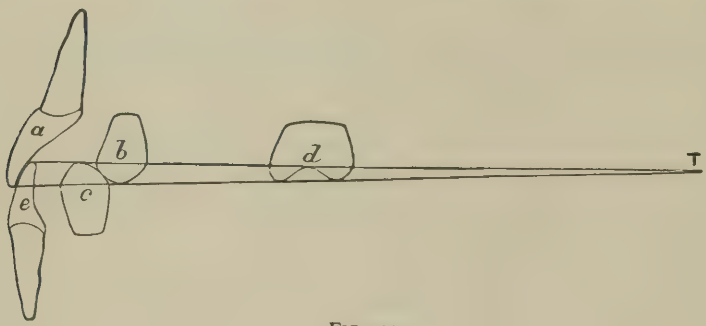


FIG. 995.

which it came had a depth of underbite of one-sixteenth of an inch or more. Where the teeth all strike fairly one upon the other and no overbite, then you have no occasion for cusps. If originally there they would soon be worn off from the abnormal articulation.

"This provision of articulation is most wise, carrying out still more fully the exact law by which the anatomical movements of the lower jaw for perfect mastication are governed. This movement we will find, in the artificial sets arranged upon this law, will prevent the plate from tilting. In the natural denture the incisors are really the first teeth to be arranged; though the first molars emerge first, to assist in the more perfect mastication of food and to keep the jaws at the proper distance. The incisors show a definite fixedness of purpose to arrange themselves after their typal shape, and to form the overjet and overbite at a given depth for the accommodation of the bicuspids and molars which are soon to appear, having cuspids of a definite

length, so that the law of articulation, which has been premeditated to a certain typal shape and construction, be carried out.

"It will also be found that the grinding surfaces of the bicuspids and molars have a typal shape—allowing them to meet with all their surfaces touching—for an express purpose, after a preordained and established law, from which the greatest area is gained for mastication; and that the inner cusps of the lower teeth are as necessary as the outer of the superior, when laterally moved. The law is still further carried out in the curvature at the ramus, from the second bicuspids to the third molar, to permit all the surfaces on one side to be in contact (Fig. 1000), while the other unused side is only partially so (Fig. 999). The nearly straight line of arrangement from the cuspids to the last molar is also in keeping with the underbite (Fig. 995).

"This triangle can only be found within a perfect circle in which you have the greatest breadth and area of surface. No other geometrical angle would have given such perfect beauty and symmetry to the face. The compactness brings the largest number of teeth nearest the center of motion. The double joint permits the greatest strength and the easiest lateral movement with the greatest range of this at the least expense of power and compass. It permits the largest number of teeth to antagonize at every movement, *and not least of all, this very triangle is the means by which nature develops the typal shape of the ramus, and of the formation of the jaws, the underbite, etc.*

"It will be observed that in making the lateral movement of the lower jaw to the left the condyle of the left side stands still or does not move backward, it merely revolves or rotates in the socket, which is but a trifle. The right condyle moves forward in the glenoid cavity fully half an inch, when at its farthest limit, causing the outer cusps of the upper, from the centrals to the last molar, to touch the outer and inner or buccal and lingual cusps of the lower on same side—the left (Fig. 1000, and J K, Fig. 998); and on the opposite side (Fig. 999, and M, N, Fig. 998)—the right—we find only the inner cusps of the bicuspids and molars of the upper to come in contact with the outer of the lower, and the centrals to the cuspids do not touch. And why so little surface touching on right side when the lower jaw is thrown to the left? You cannot masticate on more than one side at once, and when you throw the jaw to the left in the act of masticating, the food is upon that side, hence there is no necessity for the right side to have so much surface in contact. But why should it touch at all on the right? In order that the muscles on both sides should act equally, which could not be done if the teeth were not allowed to strike there, giving support to that side of the jaw, and equalizing the

force brought to bear upon that side, although no food be there. If there were no touching of the teeth on that side while mastication is going on upon the left side, there would result, as a sequence, that peculiar movement of the lower jaw at the condyloid process, which makes it difficult to place in teeth for the aged, or those even in early life who have lost all the grinders on one side.

"The form of triangle is necessary again for the purpose of giving the largest number of muscles a chance to act on both sides simultaneously and concentratedly, and thereby keeping the circle or arch of grinders down to their work, and equalizing the pressure on all sides. It enables the teeth on the side where the chewing is being done to arrange themselves when erupting, so that they will be very nearly in a line with the left condyle, which is now passive on this side, and forms one point of the dividers in forming the arc of a circle; and by this condyle being where it is—four inches from the other—the molars and bicuspids, as well as the central of that side, all come into the most perfect contact for chewing and incising, thereby carrying out this absolute natural law of the perfect adaptation of geometry and mechanics to her uses, and having no lost motion or function in any part.

"Again, the triangle gives us an extra motion forward, which brings the lower teeth in contact with the upper to incise or cut off food presented there. This could not have been with any other arrangement than the triangle. One central point at the pharynx or on the median line would have been a single swivel joint, and have brought the teeth across each other in such a way that as soon as any lateral movement commenced they would be drawn away from each other very rapidly, and but little surface be in contact. This triangle will enable you to get just the exact depth of underbite from the incisors to the last molar and the exact shape of arches; and particularly that of the ramus, which is not a matter of chance—neither is the length of cusps on the bicuspids and molars mere chance. The type has been preordained, just as the nose on your face, or the peculiar shape of the eye, or any other one part of the body. And you will find that where a superior bicuspid has a cusp of a given length, the overbite will be governed and ruled by it. It cannot be otherwise. If in the arrangement of the teeth in the human jaw no type or design were laid down in conception or embryonic life, what malformed creatures we should be, mentally and physically! *And it will be found that just in proportion as there is congenital insanity, or want of will or directing power, there will be a malformation of the teeth and their arrangement.*

"The next step is, now that we know the exact shape of the jaw

and its philosophy of form and functions, we must have at our command something so nearly approaching it that we can place our models upon it, and thus again restore nature's 'lost art.' I believe I have it here so nearly that it will be found to answer our most fastidious notions of setting by a system teeth on plate. The instrument is made of brass wire one-eighth of an inch in diameter (Fig. 994), and of such shape and movements as to correspond exactly with the mechanism of the human jaws. The base with its movements forms one part, and the two bows another. But one base is necessary for any number of cases. The bows which here are separated from the base can be duplicated to any extent. They are held firmly by thumb-screws, and after a case is once articulated to the bows they can be laid aside for future use. The lateral motion forbids the use of a prop to keep the bows apart. At first sight it would seem that the lower bow is moving in the wrong direction. Its motions are precise and correct. This has never been changed in design since first invented, in 1858. It permits of seeing whether the palatal and lingual cusps properly touch. In using it to get the lateral movement, one condyle must be kept close to the point where it is held by the spiral spring, while the opposite one moves forward. Never use both springs at once, except in bringing the lower jaw forward for incising. This method demonstrates that there is but one way to make a set of teeth articulate.

"Before placing the wax models in the articulator, it will not be out of place to say a word about this arrangement of the wax on the base plate and the selection of teeth in full sets. Always model the upper wax first, judging of the length of incisors by the trial of an artificial tooth in the mouth, such as, in shape, length, and width, would look natural and appropriate when held under the lip. This will enable you to get the height of wax and the contour after successful trial. The modeling of the wax on the upper plate is not arbitrary or fixed, so far as a definite law is concerned, in being able to work after a set pattern; here the true dental artist comes in. You get the length by trial of several blocks, or single gum, or plain teeth, as may be, as well as shade of same. As to the arch of upper, you must add to and take from, making depressions, etc., until your judgment tells you it is correct. To aid amazingly in this work of art, draw out the patient in a smile or broad convulsive laugh; compel him to do so; nothing tends so to relax most universally every muscle and give true expression to the countenance. If the wax is not in keeping with symmetry you will see where the trouble lies. Look at them in front and on either side when they are laughing, as a sculptor would upon his model. Be sure that the arch at the cuspids that form a double keystone to the arch stand out more prominently than any others. The

superior first bicuspid should nearly always fall back somewhat behind the cuspids.

"Now that the upper wax is correct, the same rule applies to the lower. It is easy to make this conform to the upper; you may have to change the upper in some respects when tried with the lower, but not much. The length of wax at the molars may have to be trimmed to allow of equalizing the length of the teeth on upper and lower plates. Laughing and smiling will here again tell. Be sure to mark the center at the median line, making marks or grooves through on either side, running from upper to lower for guide; they can be removed and are now ready for the articulator, with their bows pushed into their sockets in the base, which are retained by mere friction. The plaster models or casts with the wax articulation or bite thereon—and all fastened together by wax or cement to prevent being displaced from the cast—are now placed on this lower bow of the articulator, and the upper bow brought over upon the upper cast. Your eye soon detects whether the median line or wax is in the center. To get the cast in proper place have a pair of calipers four inches between points, and by it place the cast in position, with center of lower teeth just four inches from the condyles on either side. Hold in position while with plaster you secure the upper to the bow, and when hard, the lower bow to the plaster cast in the same way.

"It may be asked, Where is the set screw to hold open the jaws of articulation after wax is taken off? I have never found it necessary in this kind of frame. Before taking off the wax, I take a pair of dividers, or a piece of wire bent with the points about one inch and a half apart, and mark, with one foot on plaster cast and the other at cutting edge of wax, the bite at the median line. Do this for both jaws. To secure this height for future repairs mark on each cast with the dividers the distance apart or width of dividers, and this will always be your guide for height. Take off all the upper wax—except a section at the molars—first, and let the lower remain as a guide for the arch of the upper. The first block or tooth fitted on the upper when backed with wax answers perfectly to keep the jaws of the articulator apart. The set screw would be in the way with the lateral movements. I stated that the length or depth of underbite in full sets is restricted to the width of the jaws and length of the centrals, which it is presumed have been selected to suit the individual case. Knowing how much the underbite is to be, you can very nearly guess how much to cut out the bicuspids and molars on all the grinding surfaces *before any of them are fastened to the base plate*, and how much arch upward at the ramus, from the second bicuspid backward and upward. If the underbite at the centrals is to be an eighth of an inch, then the bicuspids in the

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upper will have grooves between the cusps not quite so deep, and the molars still less. From the cuspids, then, the cusps are less to the second molar; were the incisors to strike equally and directly upon each other there could be no cusps or they would be of no use. The inner cusps of the upper should, as a general rule, be longer or higher than the outer. (See Figs. 996 and 998.) The outer cusp is more acute, the inner rounded. The lower the reverse—inner sharper and outer rounded, where the upper closes over the lower. For full sets you need but slight underbite, only enough to permit the lower to come forward and act as shears for cutting; at the same time it permits of cusps to both bicuspids and molars, and gives all double amount of grinding surface, there being cusps that touch on palatal and lingual sides, at same time as the buccal. Always bear in mind that the curvature upward at the ramus, of the upper set, is always in proportion to the underbite.

"If for an upper set alone you can tell how much the upper incisors should overbite by looking at the curvature of lower molar teeth remaining. If an eighth of an inch out of line the overbite should be fully so. This, when once understood, can give no trouble. The grooves in bicuspids and molars will form with the cusps, buccal and lingual, an ogee, as seen in Figs. 996 and 998, to give double the grinding surface when worked laterally, besides giving double cutting edges. All these grooves can be cut out before any are fastened with wax, so nearly that but little touching will be needed when the lower is articulated to upper. *The first bicuspid in the lower jaw should have but one cusp.* This perfect design will be seen in the articulator why it should have but one. Two would not only be in the way of the tongue, but be of no use. Be sure that the groove in the upper is made nearer the buccal side, and for the lower or lingual side, for a reason which you will presently have explained, as seen in Fig. 996. Now that the grooves are completed in the upper and all the teeth in place in the arch, we will articulate the teeth on the lower base. The height is soon ascertained by the dividers, and the central incisors tried on to see what changes will be needed. Fasten it temporarily with wax, and try it with the lateral motion and the points adjusted to meet all the surface on palatal side of upper teeth, when the lower is thrown to the side of the tooth being fitted. Cut from the cutting surfaces of each, whichever will make the most natural and strongest case. If for a very young subject, be careful; but for a middle-aged or elderly person do not scruple about the cutting edge and grinding surfaces, but sacrifice even the labial or palatal surface for the sake of effect and usefulness.

"I sometimes turn the buccal side of a molar inward to save sub-

stance and get effect and for better adjustment; frequently for want of room at ramus I do this; and, occasionally, turn buccal side upward for the grinding surface. If using blocks, before the front ones are fastened securely to the base plate, and while they are temporarily in their right place, try the bicuspid blocks to find out how much of the joint should come off of the incisors or the bicuspid block, or divide it. This will secure a better and more continuous joint and give the lower better chance to be arranged to the upper. Before

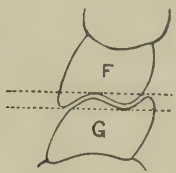

FIG. 996.

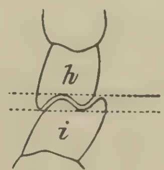

FIG. 997.

taking off too much of the joint of either of these blocks try the lower incisor and bicuspid block temporarily on wax, to know where the cusps are going to come. Regulate the joints by this. You can make the groove in the lower blocks the reverse of the upper, and cut them all out before much jointing is done, taking care that the groove is now on the lingual side and that the buccal cusps are rounded and the inner more acute, as in the buccal of the upper. *Never cut off any of the lingual cusps of the lower bicuspid and molar teeth*, such as are now made, as they are universally too short, and to

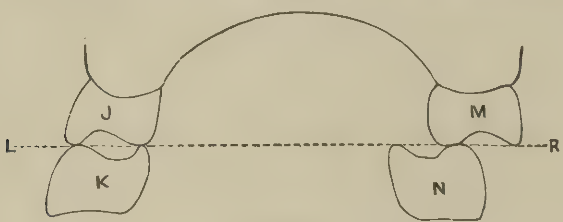

FIG. 998.

get them long enough for service a large portion of the buccal cusps have to be cut down and rounded.

"The palatal cusps of the upper strike between the outer and inner of the lower (see Fig. 996) and, at the same time, these cusps should be long enough to allow in the lateral movement the incisors and cuspid on that same side to touch simultaneously all the surface from the central to the last molar. If they do not, then your remedy is to make the groove deeper in both upper and lower, or perhaps the lower only, or the upper only (see J K, Fig. 998); experience here

will soon teach you which. When all the cusps are touching, inner and outer and the front one, take the opposite bicuspid and do likewise; and with the additional precaution, when the lower jaw of the articulator is turned to the left, to make the inner cusps of the upper strike the outer cusps of the lower (M N, Fig. 998) and *vice versa*, when thrown to the lateral right or left (J K, Fig. 998). The molars must have the same rule applied, with yet another additional point of great importance.

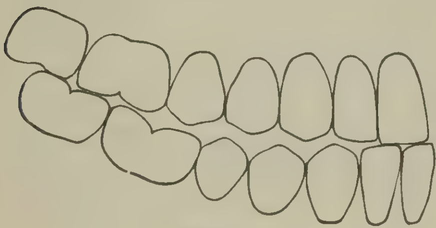

FIG. 999.

"The curvature of the ramus must be made to conform to the depth of overbite (see Figs. 999 and 1000), so that when the lower jaw is thrown to the right, the outer and inner cusps of both upper and lower sets on that side come together at the same time that the bicuspids and incisors do (see Fig. 1000); but the curvature should be great enough to permit on the opposite side of the second molar tooth in the lower, which slides forward to meet the first molar in the upper, apparently moving backward (Fig. 999)—if they were on a plane they would never touch, on account of the jaws opening as they move laterally to the right or left—to mount up on the cusps of the incisors an eighth of an inch, which would not allow the molars to touch, if on a straight line backward. But, inasmuch as on the plane of grinding surface the first upper molar stands higher in the upper plane, the sliding forward of the lower jaw in the glenoid cavity brings the higher second molar in the lower in continuous contact with the first superior molar, as well as both outer and inner cusps of bicuspids and molars of the upper and lower jaw (Fig. 999). This is specially done to equalize the pressure and force on both sides or parts of the dental arches. This permits of the most compensating arrangement of the teeth for equalizing the action of muscles on both sides simultaneously, and getting the greatest amount of grinding surface at each movement. This arrangement of bicuspids and molars is found in nearly all the lower animals; *the incisors, however, never touch when the jaws are in lateral movement.* Turn the lower jaw to

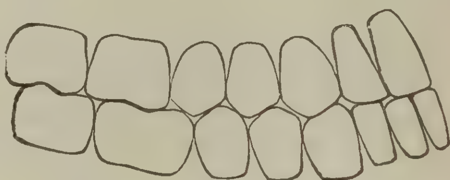

FIG. 1000.

either side and the effect is the same. *As I before said, but one side of the mouth can be used at the same instant, leaving the other free to balance the other side at work.*

"If the upper arch of incisors *of the natural teeth* should be broad or deep on account of the thickness of the base or body of the incisors, or where they are much inclined to protrude, then the arch at the ramus is not so great. In artificial sets this need never occur, carrying out the same rule in nearly every case, of controlling the curvature at the ramus by the depth of overbite and length of cusps of bicuspids. This system holds good in partial sets as well.

"This is all that is necessary to be said on articulation proper; it remains only to give a few points having a bearing on the perfection of the same. Select the broadest grinding surfaces to bicuspids and molars, that the bolus of food may be held securely on their faces, taxing less the muscles of the face engaged in mastication. Narrow surface would rather tend to cut the food than grind it. This is of no mean importance in rendering artificial teeth of greatest use.

"To produce the most natural effect the centrals should be the lightest in color, and the cuspids a shade or so darker, with a difference in color of all the back teeth. I prefer on this account to set plain teeth wherever admissible—and nearly all lower cases are so—and use different shades and arrange irregularly. The lower incisor teeth are mostly crowded, and I find to lap them over and distort them, even to a great extent, adds very greatly to their natural appearance. Don't be afraid of getting any case too irregular; very few natural sets can boast of perfect symmetry.

"After the teeth are fixed temporarily on the plate they should always be tried in the mouth to see if they are perfectly correct. As the mouth is more yielding in one part than another, the closing of the jaws rather firmly will allow of slight readjusting of themselves on the wax. If, when finished, they are found not to articulate properly—which is sometimes the case from the soldering or vulcanizing—have the patient bite on a strip of wax placed between the grinding surfaces to show the relation of each. Then put this back into the articulator and rearrange the grinding surface. It will be found to need but a trifling alteration.

"The false movement of the lower jaw at the condyles is found in nearly all persons who have had but one or two teeth remaining in the front arch, to reach which the jaw must be thrust forward and laterally; and when artificial ones are placed in, the same old movements are continued until their attention is called to it. It can be corrected without any special arrangement other than following the law herein laid down.

"*The Equilateral Triangle within the Main Triangle.*—The outline drawings in Fig. 1001 may be thought *ideal.* But any one at all acquainted with geometry, who has followed me in my argument and description, must be struck with wonder at the marvelous ingenuity of the contrivance based alone on the equilateral triangle. It will be seen that perfection must be the result, since each part is complete within itself and the whole supporting each individual part.

"How have I arrived at this divination? The law is based upon the measurement of over two thousand human skulls. First, make an equilateral triangle, 4 inches each angle, A, A, F; draw a line from T to F. What is the guide to form the arch? Know the actual width of the superior central, lateral, and cuspid at their greatest diameter from the mesial to distal surfaces, say $\frac{13}{16}$, as in Fig. 996. Measure this off with the dividers, and place one arm at F and describe an arc from D to D through I. Then place dividers at I, and intersect the line just made from F, and it will be found that at D will be found the extremest point of the arch D, F, D, and will be the distal surface of the superior cuspid. Place the dividers at I, and describe the arc from D to D through F, which will constitute the normal and positive arch of the superior jaw. There will be an equilateral triangle from D, F, I on either side of the mesial line at F. The same will be found the base of each superior incisor.

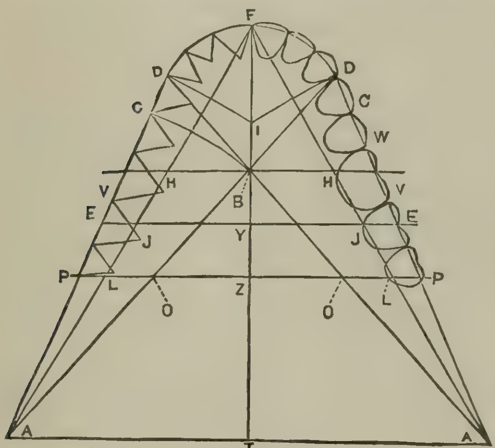

FIG. 1001.

"Next draw a line from A to D on either side, which will be the guide for the bicuspids and molars as to width and depth. Then, by placing the dividers at A and B, describe another arc to C, which will give the width of first superior bicuspid. The line from A to D passes through its palatal base, and will pass through center of base of triangle of this tooth. Form another triangle by drawing a line from H to H, through B, which will pass through the center of the first molar, and will give the width between the palatal surfaces, or their depth or thickness. Placing the dividers at I and F, we intersect the

line from F to T at Y. Draw a line through Y to E, E, forming another equilateral triangle. From B to F is now the radius of another arc, which intersects the line from D to A at V, and the line A to D at O. A line now drawn E to E through Y intersects the center of the second molar at E, E.

"Get half the distance between the points at E on the line from D to A, and the width of the first molar is made, and also the second, which is the angle of the equilateral of each. This leaves room between the first bicuspid and first molar, and is the width of second bicuspid; or it is shown by placing the dividers at A and Y, and intersecting line from D to A at W, same as from B to C, for the first bicuspid's width. The distance from D to D is the same as from D to the distal surface of the second molar. P to P through Z forms another equilateral triangle, giving the wisdom tooth's place in the arch.

"The arrangement of J and K (Fig. 1000) on the left shows the teeth in the act of mastication, while on the right M and N (Fig. 999) the inner cusp of molars of the upper and outer of the lower molars come in contact when not in use. There is double the surface touching at every lateral movement. Fig. 999 shows right side, as at M and N, and Fig. 1000 that of left side (J, K) in action from the mesial to the last molar. Fig. 996 shows both bicuspids and molars in normal relation."

Dr. W. Storer How* has described a method of utilizing plaster impressions for obtaining accurate antagonizing models as follows:—

"In the process of procuring counterparts of the jaws for which dental substitutes are to be constructed, every step should be taken with the greatest degree of exactness attainable, and accurate impressions are therefore essential as matrices in which the working models are to be cast. Impressions of edentulous jaws are commonly taken in mixed plaster, which is held in the bare tray, or in the wax impression previously taken in the tray. An elucidation of this part of the subject is not now entered upon, but it is assumed that in any case, whether the jaw be completely or partially toothless, an impression will be taken in plaster, and that, when practicable, the thinnest part of the body of the impression will be not less than the sixteenth of an inch thick. Fig. 1002 exemplifies such an impression of a toothless upper jaw, and Fig. 1003 in like manner illustrates the plaster impression of an edentulous lower jaw. In both instances the trays are omitted from the cuts as not necessary to be shown.

"Plaster impressions are commonly varnished with an alcoholic

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* *Dental Cosmos*, September No., 1888.

solution of shellac or sandarach, and then oiled to insure the separation of the casts. The preferable way in most cases is to thoroughly brush the surface with a soft brush and strong soap-suds, and, after an interval of a few minutes to allow for absorption of the water of the suds, to fill the impression with a properly mixed batter of plaster.

"Several hours should preferably elapse before attempting to separate the cast from the impression, which should be preserved as nearly entire as possible, and when there is not much overhang the separation may be safely effected by progressive smart tappings with a light mallet over the whole surface of the impression. If, however, the labial portion must needs be first cracked off, this may be done, after cutting a groove in the impression as near along the crest line of the cast as may be guessed, using quick, light mallet-blows to knock off the sections. These are to be carefully kept, and after the separation has been accomplished are to be replaced with the palatal portion on the cast and with a thin-mixed plaster built up to the approximate shape

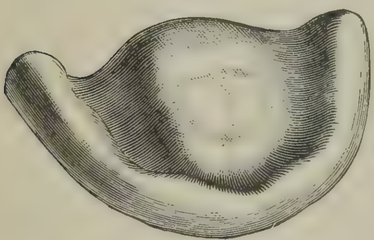


FIG. 1002.

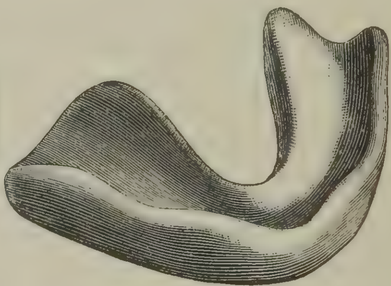


FIG. 1003.

of an articulating model. When this has become quite hard it is removed from the cast, which, of course, it perfectly fits. It will also, if as an impression it was correctly taken, perfectly fit the jaw, and may therefore be placed in the mouth and judiciously trimmed until the proper expression has been produced, and the exact dimensions and contour of the desired denture embodied in this plaster articulating model. Such a model is shown in Fig. 1004. In like manner one may prepare a similar model of the inferior jaw. Such rigid and exact-fitting models can obviously be replaced, trimmed, and readjusted in the mouth until the best skill of the dentist shall have been expended in obtaining models at once artistic and correct. The median-line mark is then made with a pencil or knife, and cross-lines are made on the sides of both models while they are pressed together in the mouth, after many openings and shuttings of the jaws, to be sure that at last the proper relations of the models have been obtained. The occluding

surfaces are then dried, warmed, some hot wax is dropped on them, the models are instantly replaced in the mouth, and the side-marks and median-line marks made to exactly coincide, while the models are pressed together by a firm closure of the jaws until the wax has quite stiffened. The joined models can then be taken from the mouth and replaced upon the casts. These are to be fixed with care in a suitable articulator, and the result will be a precise reproduction of the relative positions previously occupied by the models when placed on the natural jaws (see Fig. 1005). Attention is here called to the fact that, normally, the horizontal line of occlusion is not straight, but curved so that the superior cuspids are at the bottom of the depression, as illustrated in the lines of the models, Fig. 1005. In the construction of models for full dentures it is important to maintain this curved line of occlusion for two reasons: First, the process of mastication is facilitated by the impingement of the lower bicuspids and molars, as these

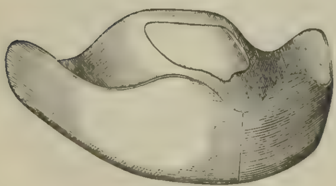


FIG. 1004.

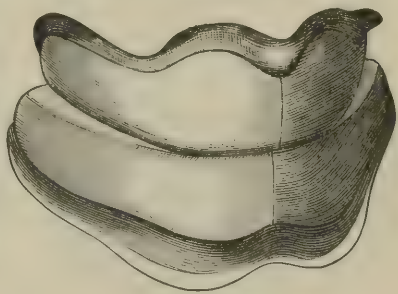


FIG. 1005.

are occluded with their downward-graded antagonists by the antero-lateral movements of the lower jaw in the act of grinding the food; second, the facial expression is improved by the rising of the respective planes of occlusion at those points, thus in some degree producing the effect that the limner accomplishes by upwardly-curved lines at the corners of the mouth.

"Fig. 1006 also shows (though imperfectly) the correctness with which the plaster models may be made to anticipate the outlines of forms which the completed dentures are subsequently to assume in becoming both useful and beautifying works of art. The thin, sharp, inflexible borders of contact with the gum along lines which provide for a firm bearing of the model, and yet permit the free play of all the muscles concerned in acts of mastication and facial expression, are noticeable in Figs. 1004 and 1005 as being producible in plaster models. It is likewise observable in Fig. 1005 that the normal overlap of the upper incisors upon the lower may be reproduced in

plaster models and prove an important factor in sustaining the lips in proper profile relations,—a circumstance too often ignored or overlooked in the preparation of the ordinary wax models. These are, in fact, commonly so crudely and clumsily formed, and are withal so lacking in resistance to adverse impressions, that not only can no dependence be placed upon them as correct representatives of the relative parts previously studied and produced in the mouth, but from the very fact that wax forms are so easy of displacement and disfigurement, the steps in the process of obtaining such articulating models are hesitatingly and hastily taken, and of course result in faulty dentures, which, more than any other class of dental operations, proclaim the frequent failure of the dentist to so closely imitate nature as to conceal the fact that such an endeavor has been made. The practical permanence of the plaster model obviates all these defects, and, furthermore, admits of such a firm final closure of the jaws

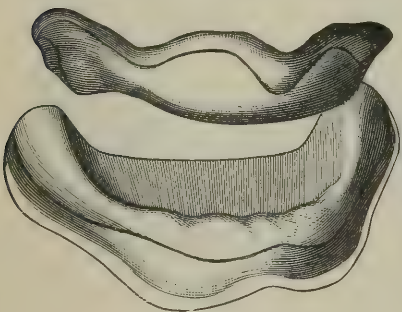


Fig. 1006.

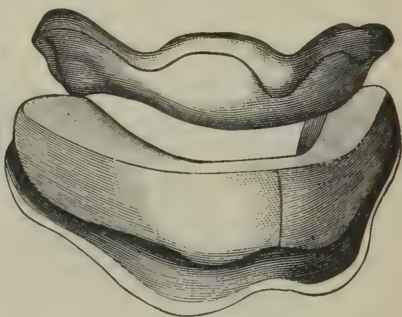


Fig. 1007.

that, when at last the corresponding denture is placed in the mouth, both the occlusion and the articulation are found to be correct, as could never be the case after a timid trial closure upon a soft, slippery wax model.

"In Fig. 1005, as in the succeeding figures, the models and casts are to be viewed as mounted on articulating frames, which do not appear because not necessary for the purpose of illustration.

"Upon the removal of the models from the casts, after these have been mounted on the articulator, both representatives of the edentulous jaws will appear as seen in Fig. 1006, and in these cases the border outlines of the models are indicated to emphasize the need of making them conform to the muscle insertion lines whenever this is practicable; and that not only because of the increased stability of the dentures when they are free from liability to displacement by the lifting action of muscles improperly so covered, but also because

the mobility of the adjacent features in the consequent naturalness of the facial expression will depend in great degree upon the judicious definition of the boundaries of the dentures.

"Fig. 1007 shows the cast of the upper jaw in its relation to the articulating model in place on the cast of the lower jaw, and Fig. 1008 likewise illustrates the cast of the lower jaw as related to the articulating model in position on the cast of the upper jaw.

"A close observation and study of these illustrations will make clear the many points of advantage to be obtained by the employment of plaster in the construction, fashioning, and adjustment of prosthetic models for full dentures.

"Complete upper artificial dentures for use with more or less complete lower natural dentures constitute a large class of the cases coming within the province of the dentist, and for these the plaster articulating models are especially adapted.

"Such a model as that shown in Fig. 1004 may be suitably shaped

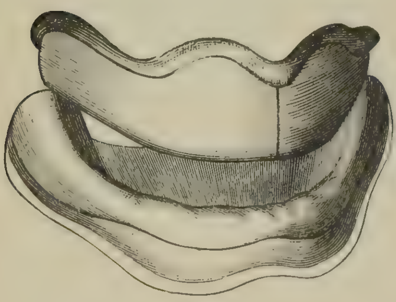


FIG. 1008.

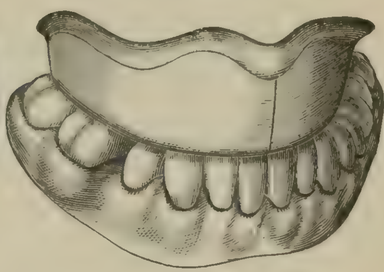


FIG. 1009.

to articulate with the natural teeth of a lower jaw, as illustrated in Fig. 1009, and in the process of shaping the plaster model great satisfaction will be derived from the security of the model's retention in the mouth, the firmness with which the lower teeth may be closed upon it, and the certainty with which, by frequent repetitions, a natural occlusion may be obtained. When this has been done, and all the artistic conditions are complied with in perfecting the shape of the model, it is to be removed, warmed, and thus dried on its occluding surface, so that a roll of very soft impression-wax may be placed upon it and all be quickly replaced in the mouth.

"Repeated normal closures of the jaws are to be made, and the jaws are then held tightly closed while the fingers of the operator are rapidly pressed upon the wax which covers the face of the teeth, so that on opening the jaws and carefully removing the model and wax there will be found an accurate impression of the teeth, which

will have to pass through the wax to the model, pressing it firmly into its seat. The result is shown in the articulated model and cast. Fig. 1010 shows the articulated casts when the model has been removed.

"If proper care has been taken in pursuing this process up to this point, the succeeding steps in the construction of a continuous gum, gold, celluloid, or vulcanite denture may be taken with complete confidence that the substitute, if made in strict conformity to the models, will exactly fit the maxilla, articulate with the natural teeth, and impart an appropriate expression to the related features of the patient.

FIG. 1010.

"The foregoing method may in some cases be practiced when modeling composition has been used in taking the impression; or the composition may be employed in building the model upon the cast which has been made from a plaster impression. But for general use—and all the more so as the practice shall become familiar—plaster will be found most reliable and satisfactory as a material for both the impressions and the models."

CHAPTER XI.

SELECTION AND ADJUSTMENT OF PORCELAIN TEETH TO THE PLATE—FINISHING TOUCHES.

In selecting porcelain teeth for dentures a number of points must be considered, such as *Size*,—width and length, especially of the front teeth; *Shape*,—straight or wedge-shaped; *Shade*,—to conform to age and temperament, and for partial dentures to match natural teeth in the mouth; *Character*,—flat, or curved on the labial surfaces, transversely or from the gum to the cutting edge, thin, translucent, and delicate, or thick, dense, and massive; *Peculiarities*,—the presence or absence of grooves, ridges, or lines, straight or rounded cutting edges.

Where vacancies between natural teeth are to be filled it is highly important that the artificial teeth should correspond in shade and

color with the natural organs; for in proportion as they are whiter or darker, will the contrast be striking and their artificial character apparent. Of the two faults it is better that they should be a little darker than any whiter. They should also resemble in shape those which have been lost, so far as it is possible to ascertain this. Minute accuracy as to shades of color involves the necessity of a large assortment, unless one is located near a depot or agency. But the facilities of mail and express greatly lessen this necessity, provided there is time to send for the tooth or teeth required. It is desirable, in view of this method of matching shades of color, to keep all refuse or broken teeth to be used as samples in sending orders.

The manufacturer supplies three varieties of plate teeth—plain, gum, and sections. The latter have the advantage of showing few joints, but are less easily repaired and are not applicable to so wide a range of cases. Gum teeth or sections are applicable only where there has been sufficient absorption to permit the extra fullness of the artificial gum. Many mouths are deformed by a foolish craving on the part of the patient, which the dentist is equally foolish in yielding to whenever plain teeth are more appropriate. In point of strength, durability, and facility of repair, plain teeth are superior to the others; they are also more readily adapted to the plate.

The manufacture of gum teeth in sections of two, three, or four teeth has been brought to such perfection that comparatively few single gum teeth are now used; especially since new methods of attaching these sections to the plate have rendered unnecessary that exact fitting of blocks which was one objection to their use. This perfection of manufacture has also done away with the necessity, on the part of the dentist, of devoting to the making of block teeth the very large proportion of his time formerly demanded by this difficult process. Whenever special cases demand blocks or sections made to order, it will be found more satisfactory to send proper models and descriptions, and have such teeth made by those who are thus constantly occupied, than to incur the disappointments and delays inevitably attendant upon infrequent and irregular attempts at block-work.

For the proper shaping of models and articulators to accompany such orders directions will hereafter be given. These blocks, when received, do not need much, if any, grinding. But all plain teeth, single gum teeth, and ordinary sections or block teeth require, after selection, to be more or less accurately fitted to the base plate. For this purpose they must be ground on emery or corundum wheels until accurately fitted, and must be so arranged, in full cases, as to meet the teeth with which they are intended to antagonize at the same

instant around the entire arch ; in partial cases the natural teeth should touch their antagonists more decidedly than the artificial ones. A correct articulation will enable the dentist to antagonize the teeth with perfect accuracy.

The movements of the tongue, lips, and cheeks must be considered in the adjustment of artificial teeth, and the expression must be carefully studied ; hence some general rules may prove serviceable. The median line of the face should exactly come between the upper and lower central incisors ; the centrals and laterals on each side should lean slightly toward the median line, the laterals a little more so in most cases than the centrals, the cuspids very slightly, and the bicuspids and molars almost perpendicular. In a full denture the anterior teeth should lap but slightly, only enough to permit the cutting edges of the upper front teeth to pass over those of the lower teeth ; the six anterior teeth, therefore, should not meet, but the pressure should be upon the bicuspids and molars, and be equal on both sides. Lisping is prevented by having the front teeth lap but slightly, and the stability of the denture is increased. The articulating model will govern the length of the teeth, especially the anterior ones. The arrangement of the posterior teeth should correspond to that of nature, the articulating surfaces of the inferior second bicuspids and first molars curving downward, so that the second bicuspids and first molars are somewhat shorter than the first bicuspids and second molars ; by such an arrangement the denture is less liable to be forced forward in mastication.

For proper expression the anterior lower teeth should occupy a perpendicular position, as it is seldom necessary to incline them outward or inward. Even when the lower jaw projects somewhat the lower teeth should be perpendicular and the upper teeth incline or project out to meet them. Fullness of the gum under the nose should be avoided, as the lip is given an unnatural fullness by such a thickness of material. It is frequently necessary to make considerable fullness of the gums of the cuspid teeth.

There should be an outward curve of both upper and lower teeth when the face is observed in profile.

In arranging an entire set for the upper or for both jaws the molars should be so adjusted that the inner or palatine tubercles come together as well as the outer ones. This precaution is necessary in antagonizing single as well as block teeth. If the outer tubercles strike first the pressure there will spring and loosen the plate. For the same reason upper molars and bicuspids should not be set so that the force of mastication falls outside of the ridge. The inferior teeth should be placed well on the alveolar ridge, and not inclined

inward or too much outward, and sufficient space be allowed for the movements of the tongue.

The lower teeth of an entire denture may with advantage be longer than the upper teeth, and thus insure greater stability; hence the lower front teeth (incisors) should be arranged first, then the upper teeth of the same class, and the same rule followed in regard to the remaining teeth. An unnatural regularity in the arrangement of artificial teeth should be avoided, as a slight irregularity will often harmonize with the features. The first bicuspids of the upper jaw should articulate between the first and second bicuspids of the lower jaw, so that each tooth meets two opposing teeth. The upper first bicuspids should be partially hidden by the cuspids when the denture is in the mouth, and the upper bicuspids and molars should project slightly over the corresponding teeth in the lower jaw.

Placing artificial teeth outside the ridge is often a cause of failure in securing serviceable dentures. The curve of the arch in both jaws should be made by the six anterior teeth, and by these alone. The prominence of the cusps of the posterior teeth should be preserved; hence the necessity for careful articulation, that it may not be necessary, after the denture is completed, to grind off the masticating surfaces of such teeth. The greatest pressure of mastication should be upon the second bicuspids and first molars; hence the second molars may be arranged so that they are somewhat shorter than the teeth referred to.

In partial upper dentures supplying the first and second molars, and in some cases also the bicuspids, on both sides, should a natural inferior molar remaining in the mouth have an inclination forward, as is generally the case when the teeth in front of it are wanting, such a tooth should be avoided in the articulation; otherwise, the denture is liable to be forced forward by the pressure of such a natural tooth against the teeth on the denture, as such pressure increases as the jaws are closed together.

A small space should be left between the last tooth of the upper and of the lower jaw in those cases where the crown of the lower molar looks forward, its posterior edge being a little higher than the anterior.

It is often necessary to cut away a considerable portion of a tooth in order to make it fit accurately to the plate. This makes the process of grinding very tedious, unless the operator has a number of sharp-cutting wheels varying from half an inch to three or four inches in diameter. Corundum wheels of various shapes and sizes are employed for grinding teeth; also wheels of carborundum, a new material composed of carbon and silicon, the combination being effected by

electrical action; it is claimed that carborundum wheels and points cut faster than corundum, and may be used wet or dry.

Fig. 1011 represents an excellent form of corundum wheel (the suggestion of Dr. S. Lee) for jointing porcelain gum teeth, and is made of various grits.

These wheels may be attached to a hand lathe, such as represented by Fig. 1012 (Coy's noiseless hand lathe). The foot lathe is, however, far more convenient for laboratory use, where much grinding is to be done. Of these the depots furnish some excellent varieties. Fig. 1013 and 1014 represent the Snowden & Cowman and the S. S.

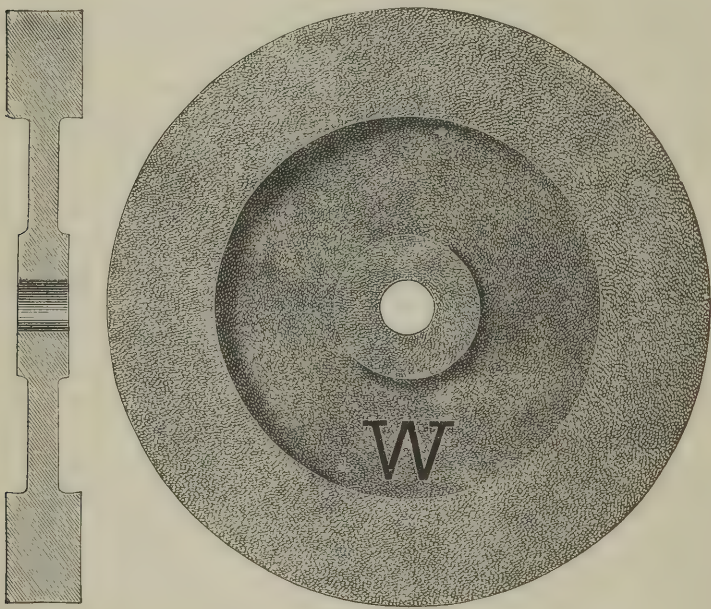


FIG. 1011.

White, which are admirable lathes for dental purposes, while in Fig. 1015 we have the Amateur lathe, which is a larger, stronger, and more powerful lathe, capable of very rapid motion; also adapted to the making of small instruments, handles, etc.

The lathe of Dr. Lawrence, with detached driving wheel and head that can be attached to any convenient board, shelf, or table (Fig. 1016), has advantages that will make it very desirable to many.

Wheels may either be set at intervals on a long spindle, or screwed singly on the end of the mandrel (Fig. 1016). In the latter case they should be fixed with a screw chuck in the center, so as to be quickly changed from coarse to fine or from large to small. In grinding the

wheel should revolve toward the operator and be kept constantly wet with a sponge held either in a sponge-holder or between the ring finger and little finger of the left hand.

The thumb and forefinger of each hand must be free to hold the

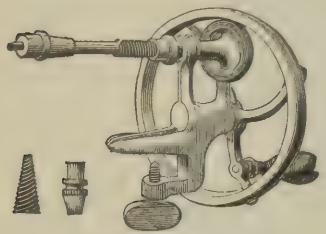


FIG. 1012.

FIG. 1013.

FIG. 1014.

tooth, the right wrist being steadily supported on the hand rest (Fig. 1017). Two faults are very common in grinding; one is revolving the wheel too rapidly; the other, bearing the tooth too heavily against the wheel. The first hinders rather than helps grinding; the second

is very apt to throw the tooth from the fingers and destroy the delicacy of touch necessary for accurate grinding.

Fig. 1018 represents the Coolidge grinding lathe head, which is also operated by a driving wheel, and can be attached to a table, and is an admirable appliance.

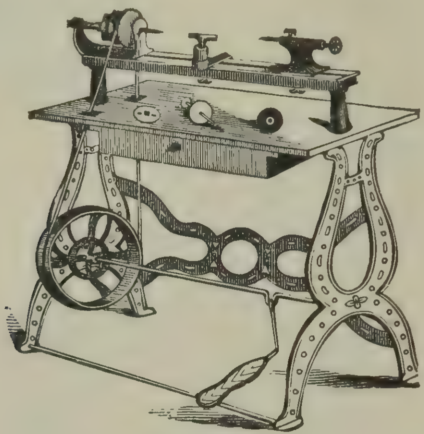


Fig. 1015.

In grinding blocks and gum teeth, and often in plain teeth, very small wheels are required to make them fit the curves of the plate. Thin edges of gum teeth and blocks must be ground with very fine-grained wheels; in jointing them a three-inch wheel should be used,

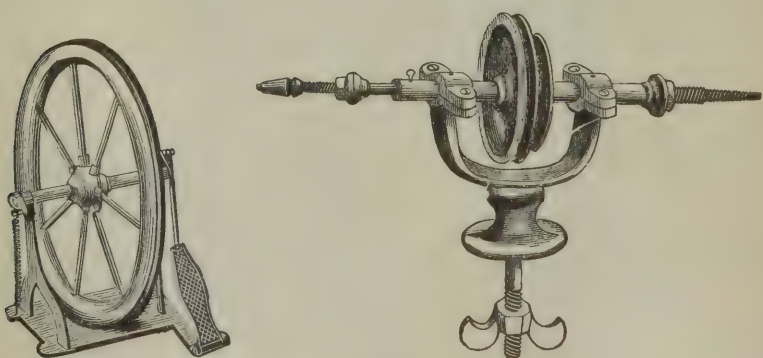


Fig. 1016.

perfectly flat on its outer side, and running very true (Fig. 1011). Wheels when worn down to small size increase in value, because they grind out curves inaccessible to larger ones. In warm weather large and thin wheels, when not in use, should rest on a flat surface; such

wheels are often warped by the softening of the shellac as they lie carelessly among other wheels. Wheels running on the end of a mandrel and attached by a screw chuck can be made to run true by warm-

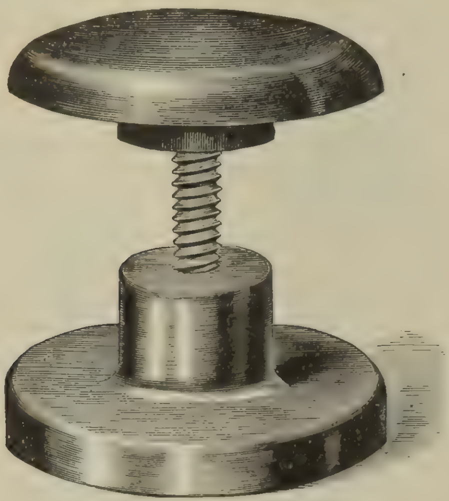


FIG. 1017.

ing the mandrel with a spirit lamp, and at the same time revolving the wheel rapidly.

The accuracy of the fit necessarily depends upon the kind of work

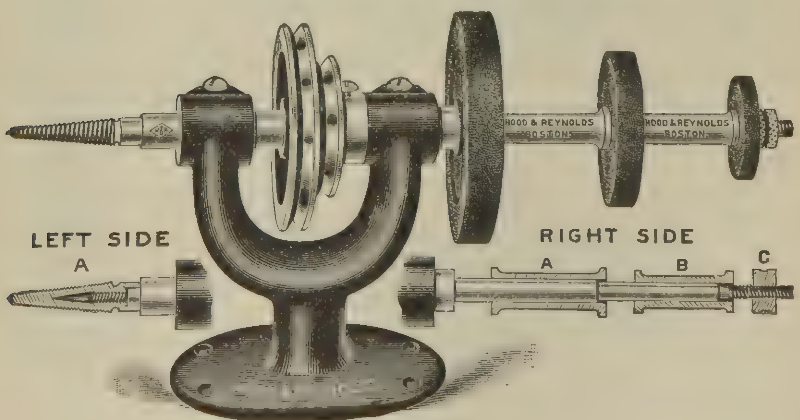


FIG 1018.

and mode of attachment to the base plate. In general terms it may be stated that whenever any permanent plastic material is in contact

with the base of the teeth, or forms the bond of union between the teeth and plate, grinding is much simplified. It is sometimes better in such cases to have a moderate space between the base of the tooth and the plate or the model, than to have actual contact. But in all cases the lateral jointing of block or single gum teeth requires care.

The order of grinding a set of teeth is usually to fit the central incisors, then the laterals, next the bicuspids, and so on ; in case of sections, in the same order. This order will be found most conducive to uniformity of arrangement ; of course, it may be modified to any desired extent. In case of a double set there is much diversity of practice. Some adapt, first, the entire upper set, others the entire lower ; some, again, adjust the two sets of incisors, then the bicuspid blocks of both pieces, lastly, the molars. Whichever method is adopted, when all or part of one of the articulating rims is removed, the antagonizing rim must be retained to guide in the adjustment of the teeth.

Fig. 1019 represents a holder for teeth while grinding ; a slot admits the pins, and the side clamp holds the tooth securely.

During the process of grinding the teeth are temporarily attached to the plate in several ways. Either the articulating rim is cut away sufficiently to receive the tooth (Fig. 1020), or the rim is entirely removed and its place supplied with a mass of wax covering the plate to the top of the ridge, and to which the teeth are severally attached as they are ground ; others fasten the teeth to the plate with cement. Dr. Richardson gives the following formula for a tenacious wax for temporarily securing the teeth : Beeswax, ℔. j ; gum mastich, ℥ij ; Spanish whiting, ℥j.

For melting wax and its compounds in temporarily attaching teeth to metal plates and for "waxing up" the plastic work, the small Bunsen burners represented in Figs. 1021 and 1022 will be found very useful.

Fig. 1023 represents what is known as the "Duplex burner," which is well adapted for laboratory use. To the usual Bunsen burner is added a large flame for the blowpipe, which is applied by rotating the upper portion upon the base. By means of a small jet either flame can be ignited, rendering it always ready for use.

An excellent "waxing burner" is shown by Fig. 1024. The tube cannot be clogged with wax, as the heat will melt it and it will escape at the opening for the air-supply.

Definite rules of arrangement, or wood-cuts illustrating various forms of teeth and manner of setting them in the arch, are not all that is necessary. This branch of dental esthetics must, of necessity, be worked out by every one for himself. He will succeed or fail just in

proportion as he has the ability to observe the hundreds of models which are perpetually before him, and as he has the further and rarer ability to apply his observations to the special cases that are in his laboratory.

Imitation of nature is the rule. Imitations of art and individual

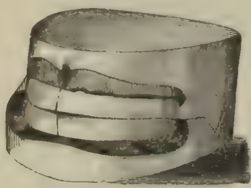


FIG. 1020.

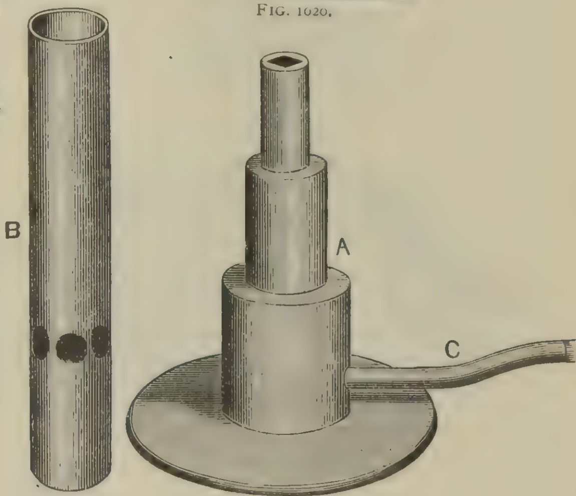


FIG. 1021.

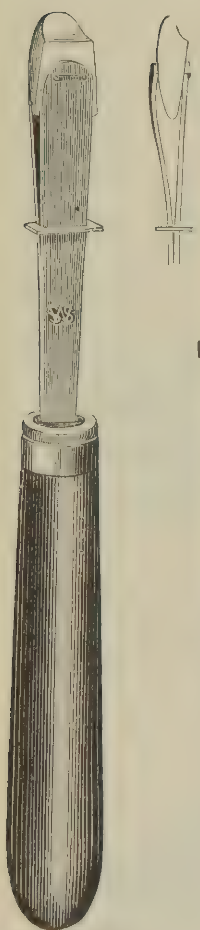


FIG. 1019.

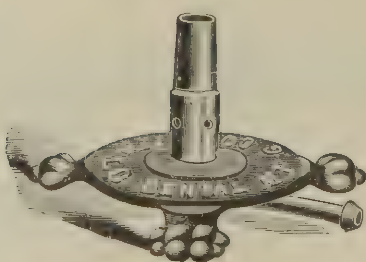


FIG. 1022.

incapacity make exact observance of this rule comparatively rare. We replace the sixteen teeth with only fourteen, and often make them shorter and every way smaller than the natural organs. We do not make the grinding surfaces interlock with such deep cusps as in nature.

At one time we cannot avoid an unnatural fullness of artificial gum; at other times the contraction of the absorbed arch compels the setting of molar teeth nearer the median line than the original teeth.

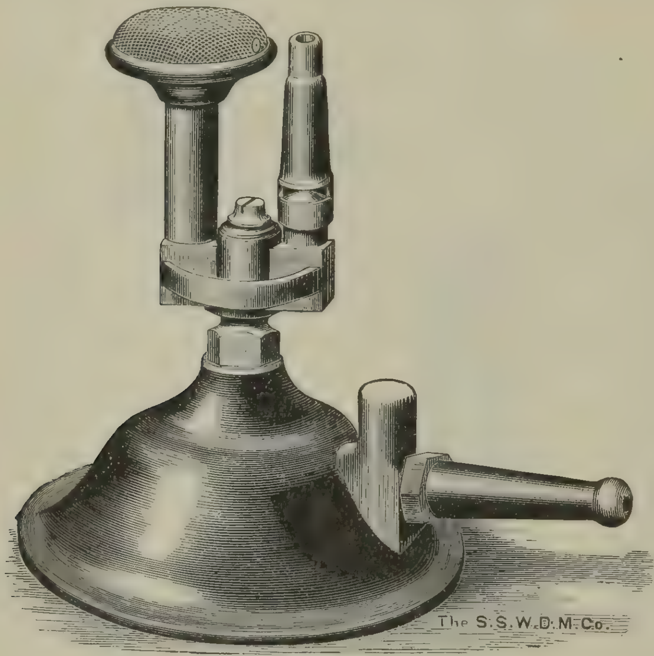


FIG. 1023.

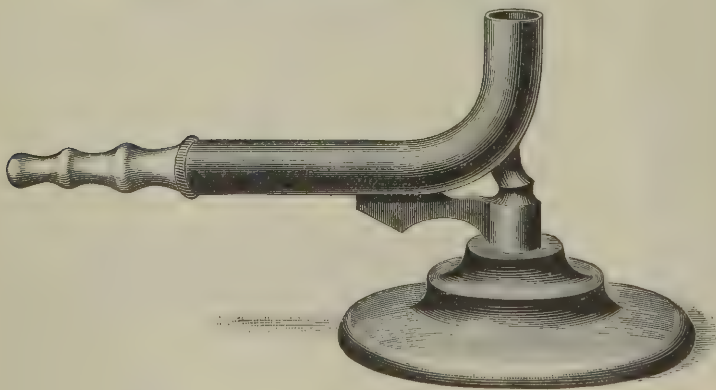


FIG. 1024.

Notwithstanding these and many other disadvantages the perfection of the dento-ceramic art is such that a skilled artist who is quick to observe what nature requires can in the majority of cases falling under

his care supply the lost dental organs with great accuracy, and preserve that higher order of beauty which grows out of the harmony of his work with the expression of the face and entire person. But no dentist can give to his work this kind of beauty who does not systematically study the natural organs as they daily present themselves in the operating chair. Few patients would object to the pressure of a roll of wax (two inches long and about half an inch thick) against the closed teeth. A model from this impression would give the size, form, arrangement, and articulation of all except the molar teeth. A well-matched porcelain tooth (more than one might be required) would add to these data the color of teeth and gum. To this add also the age, sex, physical characteristics of the face, and the physical temperament. If the dentist would have a case-book for the registration of one such carefully made observation every week he would, at the end of two years, have a collection which as a practical guide in the selection and arrangement of artificial teeth would prove of incalculable value. These fixed records of minute details are made still more useful by a habit of close observation in society. In this way a set style, or mannerism, may be avoided, which so often stamps work with meaningless uniformity of expression.

Artificial teeth should imitate the natural organs; yet there is a perfection of form and arrangement which it is not advisable to imitate. To disarm suspicion as to their artificial character, it is often desirable to impart a measure of irregularity. An overlapping lateral, a missing bicuspid, a worn canine, an incisor, bicuspid, or molar apparently decayed and filled with gold, an exposed neck from absorption of the alveolus, are among the legitimate devices of the skillful mechanician who has the "art to conceal his art." If there are any defective natural teeth remaining to be matched, still higher art is required. A perfect porcelain incisor is no fit companion for one that is partly broken, decayed, and discolored; and since no art can make the defective tooth perfect, and yet the patient retains it, there is no alternative but to give so much imperfection to the artificial one as shall take away that striking contrast which so painfully offends our esthetic sense of fitness.

In this class of operations a "diamond drill" is of great value; in fact, so very useful is it in many ways that we regard it as an absolutely indispensable instrument in the laboratory. Cutting away parts of teeth or blocks inaccessible to wheels; changing the shape of teeth near the gum; drilling cavities to be filled with gold, or holes for the repair of broken blocks, these are some of the operations which the diamond drill will accomplish as no other instrument can.

The selection and grinding of artificial teeth require, first, a high

order of esthetic culture; secondly, great patience and skillful manipulation. The latter are often taxed to the utmost to make a set of blocks answer the requirements of a given case; especially when the blocks must be closely fitted to a gold plate preparatory to attachment by soldering. Single gum teeth are more easily fitted to the plate; but there are some joints; hence it is doubtful if much time is saved. The principal advantage of single gum teeth is that a single tooth, if broken, may be replaced without interfering with the adjoining ones. Another reason why many prefer them is that a small stock of teeth in this form is adapted to a larger variety of cases than blocks would be.

We think, however, that dentists living at a distance from the manufacturer should depend upon a great variety of samples rather than upon duplicates of certain forms, however desirable.

In joining a set of blocks or single gum teeth one point must be remembered which has already been alluded to. In soldering the metal expands, while the teeth held in the investment are brought closer together by its contraction, and in this slightly altered position they are soldered to the plate. The contraction of the plate on

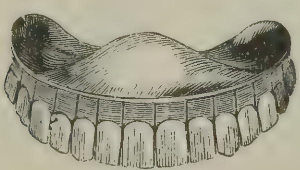


FIG. 1025.

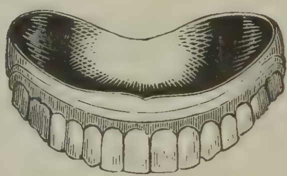


FIG. 1026.

cooling is irresistible and may result in one or both of two accidents —chipping off the brittle edges of the teeth thus brought too closely together, or warping the plate because of the resistance which the teeth or blocks offer to the contraction of the plate. Thin letter paper slipped between the side joints will suffice to prevent these accidents.

Fig. 1025 gives an external view of a full upper set of single gum-teeth, arranged on a gold plate, preparatory to the operations which precede soldering, or other modes of fastening them to the base. Fig. 1026 is a similar view of a set of blocks, with a soldered rim covering the upper edge.

Usually, in first or temporary pieces, and sometimes after the alveolar absorption is completed, the fullness of the gum is such as to forbid the addition of an artificial gum to the ten incisors, canines, and bicuspids. In such cases the plate must be cut away from the front of the ridge as far as the first or second bicuspid, and the teeth ground with great accuracy to fit the gum itself. Single plain teeth will usually be best adapted to such cases; but an excellent effect can

sometimes be produced by grinding a block, when the shade of gum is well matched, to fit directly upon the natural gum. In partial cases the tooth or block must invariably be fitted to the gum; no plate should be seen above or at the side. In fitting directly to the plaster model this should be scraped (after the tooth is ground), so that it may press firmly on the corresponding gum.

The teeth or blocks being now arranged and fitted to the plate, the next step, preparatory to soldering, is to get access to the pins on the inside for the purpose of backing them. Set the articulating model on the table with the teeth upward; bend a strip of lead (an inch wide) outside the arch and about half an inch from the teeth; then fill the space with plaster, inserting a strip of tin foil opposite the median line, so that the plaster rim will readily break at that point when removed. In a double set do the same with each half of the articulator. When the plaster has set remove all wax or cement from the teeth and plate, and proceed to examine the pins, also the relations

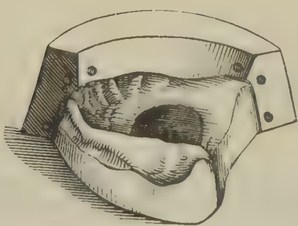


FIG. 1027.

FIG. 1028.

of the teeth or blocks to the plate and to each other. This temporary plaster band we regard as essential in every case, except a few varieties of partial sets. It is equally essential in vulcanite and other forms of plastic work, as will be hereafter explained. It is a common but not good practice, where the teeth are soldered, to substitute for this temporary band the soldering investment.

Fig. 1027 will give an idea of the shape of this rim, except that, being here designed for a different purpose, it does not show the impress of the teeth. Fig. 1028 represents the inner surface of a set of blocks with the wax removed, which we may suppose just withdrawn from the plate in the preceding figure. Blocks or sections are readily replaced in their proper positions; but single teeth are sometimes so similar, especially bicuspids, that they are apt to be misplaced. To prevent such accidents have a circular wooden block four inches in diameter, with twenty-eight cups or depressions, so marked that each tooth can be instantly put into and taken from its proper cup.

The teeth being thus arranged, a gold plate or backing large enough to cover the entire width, and from eight- to nine-tenths of the height of the posterior surface of each, is fitted to them in the following manner. Each tooth has securely fixed in the back part of it two platina rivets for the purpose of connecting it to the backing. Each backing, therefore, should have two holes punched through it by means of a pair of punch forceps, as represented in Fig. 1029, large enough to admit the rivets of the teeth. After having punched one hole a rivet is inserted; then by moving the strip of gold plate two or three times to the right and left a mark will be left upon it, indicating the distance the rivets are apart. But previously to this the rivets should be made parallel (being very careful not to strain them in the tooth) and the ends filed off level. Otherwise the pins will not

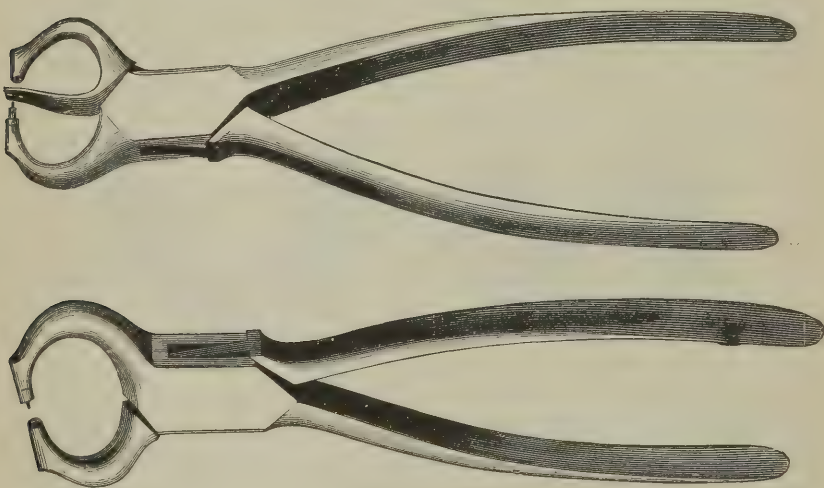


Fig. 1029.

go into the holes punched, and there will be an uncertainty as to which side of the pin the mark on the plate corresponds.

Dr. Samuel Mallet has very ingeniously invented a punch which will save much trouble in finding the proper position of the second hole (Fig. 1030). After straightening the pins, one is placed in the hole, *i*, at the head of the punch, the other pin pressing out the movable punch, *e* (which works by the spring, *g*), until it slips into the slot, *h*; the two punches, *f* *e*, then make the holes at the exact distances apart to receive the pins.

A simple form of punch, and one not liable to accident, is a piece of steel half an inch square and three or four inches long. It consists of two halves riveted together at the top, each tapering nearly

to a point. By turning a small screw, inserted midway in one leg, the points held opposite the pins are separated to their exact distance. A slight tap of the hammer marks this upon the backing, and then the holes are made with an ordinary punch. Pins often set very irregularly in a tooth; they should be parallel, but not necessarily perpendicular. Too much bending of a pin close to the tooth makes it more liable to fracture in soldering or by use in the mouth. Pins also

FIG. 1030.

vary much in thickness; it is better to have the pin of the punch forceps of medium size, and to ream with a broach for large platina pins. A set of broaches are indispensable in backing teeth and in many other operations.

The holes should be slightly countersunk on both sides, and after placing the backing on the tooth it is made fast by splitting with a strong knife or a wedge-shaped excavator the ends of the platina rivets or pinching them together with pliers. If the ends of the

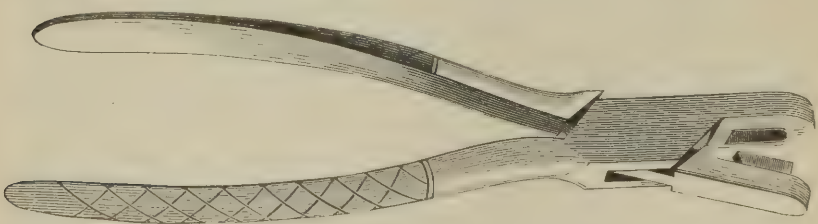


FIG. 1031.

platina rivets are hammered so as completely to fill the holes in the backings, it will prevent the solder from flowing in and uniting the two as firmly as it should do. The backings should be slightly hollowed before they are put on; by so doing they will fit up closely to every part of the back of the tooth. Fig. 1031 represents a pair of forceps designed to give a general form to the backing by punching it from a piece of gold plate of the required thickness.

After the backings have been made fast to the teeth they are to be accurately fitted to the plate, standing off from the plate enough for a very thin piece of watch spring to be passed under it. This shows that the tooth is not raised by the backing from its place in the investment. A much wider space makes the flow of solder uncertain; the practice of placing scraps of gold under badly-fitting backings is a very slovenly one; and where such imperfections occur it is much better to fill such spaces with gold foil.

Some dentists back the teeth as they grind and fit them and before investing; others invest with the plaster and sand, and back without taking them from the investment; others, again, partially invest with the soldering mixture, remove, and back the teeth, then replace, and add more plaster and asbestos or sand over the edges of the teeth. The last method is unsafe, because the two layers of batter are apt to separate in heating and may displace the teeth.

Backings (called also stays or standards) vary much in size, shape, and thickness. Some variations are matters of taste; as, whether they shall be rounded, square, or beveled at the top corners; whether chamfered to a thin edge, or left thick, and then beveled or rounded. But other points often considered optional are not so, inasmuch as they affect the appearance or stability of the work. Backings which cover the translucent edge of the tooth darken it by the refraction of the oxidized surface next the tooth, and which cannot be kept bright; even if it could, the gold would impart a yellowish tinge. They should cover enough of the tooth, and fit so accurately as to prevent motion of the tooth; for this will inevitably cause the pins, sooner or later, to break off. Backings, in relation to each other, must either be so far apart at their base that the solder will not flow from one to the other, forming a continuous band, or they must be in contact throughout whatever distance the solder will unite them. This rule is particularly applicable to backings of single gum teeth, which are often (perhaps usually) made the full width of the tooth up to the shoulder. This continuous band gives great stiffness to the plate. But the contraction of the solder will certainly warp it, unless prevented by actual contact of the edges soldered. In case of plain teeth a heavy, continuous line of solder will almost certainly warp the plate. A block may be backed for soldering in one piece, or in parts closely fitted, or in distinct backings opposite each tooth. A block much curved is with difficulty backed in one piece; long or thin blocks are liable to be cracked by the contraction of a backing, either in one piece or made continuous by soldering. Backings should be of the same gold as the plate, but heavier, especially if long or large.

Sometimes the shape of a gum or block tooth may require the

removal of the plaster rim, which can readily be done; then replaced after the backing is completed for the final adjustment of the teeth. The teeth are next to be fastened to the plate with a small quantity of cement (resin mixed with wax, or, still better, the wax, gum mastich, and whiting compound), and a small roll of softened wax (not melted or made adhesive) placed over the entire surface to be soldered. In Fig. 1032 the inner band may be taken to represent the width of this wax roll, which is of great service in preventing any plaster of the investment from getting accidentally upon the parts to be soldered. If the teeth have been previously soldered to the backings this wax strip should be narrower; but if rivets and backings are to be soldered at the same time, the rim must be made carefully to cover every point where solder is to flow. The plaster band is then very carefully removed and the piece surrounded with the soldering investment, which must be no thicker than is sufficient to protect the teeth and hold them in place. The wax and cement are easily removed, leaving the surfaces perfectly clean and ready for the borax and solder. The investment should not project so far over the inner edge of the teeth as to obstruct the blowpipe flame; it should not cover the lingual surface of the plate, nor should it be thick on the palatine surface. On the palatine side it might be well also to cut along the median line nearly or quite through the investment; the object of this is to give play to the lateral expansion of the plate, the antero-posterior expansion being usually, from the shape of the plate, sufficiently free. This we regard the simplest and best method to prevent warping of the plate, so often caused by the very means taken to prevent it.

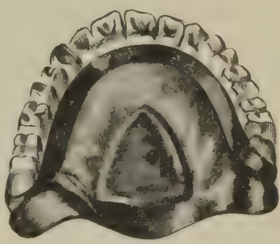


FIG. 1032.

We have said nothing of fastening the teeth with a firm body of cement instead of wax, so as to try them in the mouth before soldering, because a correctly taken articulation makes this unnecessary. As remarked in the chapter on articulation, this process admits of perfect accuracy. Its very object is to prevent the necessity of any change in arrangement after teeth are adjusted. An error of articulation will often involve a change in the jointing of blocks more troublesome than the original grinding; in fact, neatly ground blocks (or gum teeth) will not permit the slightest change of position without fresh grinding somewhere. Trial of teeth, merely to test the correctness of articulation, may in some cases be especially necessary when used to test correctness in the selection of teeth; for it requires experience to en-

able us to determine, *a priori*, just what style of work is best adapted to the case. But the awkward and momentary retention of a plate to which the teeth are so slightly attached is no test of its esthetic correctness, unless the selection has been grossly misjudged. It is only after the patient has become habituated to the piece, giving time for the natural form of the lips and motions of the mouth, that we can best decide whether or not our work has beauty of expression as well as artistic finish.

Mr. Andrew Wilson, of Scotland, adopts the following method of backing teeth: After having partially fitted the tooth to the plate, take a piece of platina foil, as thick as can be used conveniently, and, pressing it against the tooth, perforate it where it is marked by the pins; then cut it into the required shape of the backing and press it as closely as possible to the back of the tooth. Apply a little borax to the platina pins which come through the back; then place the tooth, with its face downward, upon a thin piece of pumice, covered with dry plaster, putting upon the platina sufficient gold for the thickness required; slowly heat it, gradually raising the heat until the gold melts, when it will rapidly flow over the whole platina surface, uniting so firmly with the pins in the tooth that Mr. W. has never, during eight years' use, seen a case in which they have loosened, even where there has been sufficient violence to break the tooth. After the backing has been run and the tooth allowed to cool slowly, it is filled to the requisite thickness and shape; tooth and backing are then closely fitted and finally soldered to the plate. In arranging the teeth on the plate for soldering, Mr. Wilson uses an investment of white sand and plaster, equal parts, placing a thin strip of platina on the outside of the teeth, with a layer of the investment on both sides of it, so that, should the plaster crack in soldering, the platina may keep the teeth from shifting their places. The whole time occupied in heating and backing a tooth is about half an hour; when several are done at once a little longer time is required. Of course, all the backings of the set should be flowed at the same heating.

Instead of using the strip of platina plate to prevent the teeth from becoming displaced, in case the plaster cracks, thin sheet-iron rings one inch deep or iron wire may be used; but platina is undoubtedly the neatest, and has the advantage of being indestructible; it may be narrow and thin, so that its cost would form no objection to its use. But if the plaster is not in excess the investment will not crack. A batter made of three or four parts of asbestos to one of plaster will stand the hottest fire of the laboratory. Many prefer equal parts of plaster and sand, as forming a more solid investment in which to back up the teeth. Mr. Wilson's method might be improved, first, by

completely fitting the tooth before backing; secondly, by running the thin platina backing one-sixteenth of an inch on the plate, to any irregularities of which it can be quickly burnished down. This flange secures a very perfect and strong attachment to the plate, and is the method of backing (with heavier platina) sometimes practiced in the continuous-gum work.

Ordinary backings, after they have been fitted to the plate and held to the teeth by bending or splitting the pins, may be removed from the plate, set in a batter of plaster and asbestos, and soldered; the plaster should be so stiff as not to flow over the backings. The solder

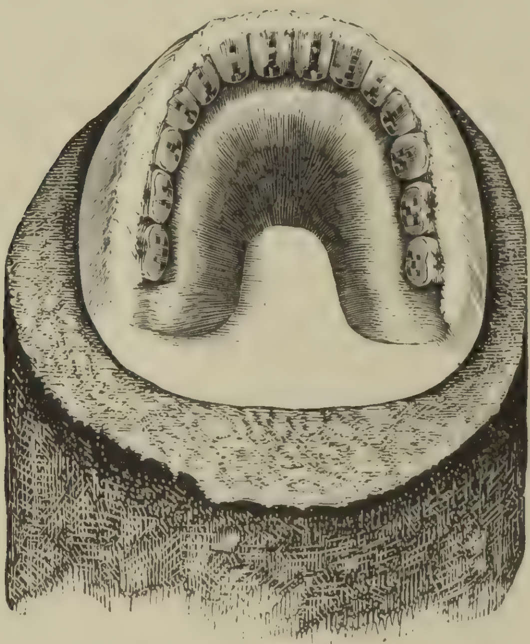


FIG. 1033.

should be rather harder to fuse than that used to fasten the teeth to the plate. The backings, after slowly cooling, should be filed, and may even be Scotch-stoned. Backings can be better and more quickly finished singly than when attached to the plate. This method, or Mr. Wilson's, is much to be preferred to the common practice of soldering the backings to both teeth and plate at the same heating.

A piece invested preparatory for soldering and placed upon a lump of solid charcoal is seen in Fig. 1033.

Directions for applying borax and solder are given in the chapter on

soldering. Some cut the solder into very small pieces; others use one piece to each tooth at its base, and a second for the pins unless previously soldered; in the figure the pieces are unnecessarily small. If the backings are soldered to the teeth beforehand a more fusible grade of solder should be used at the second soldering. The work must be very gradually and thoroughly heated up before directing the flame upon the plate or backings. The last point to be touched with the flame is the solder, and this not before a slight melting of the edge shows that it is just on the point of flowing. If every preparation for soldering has been properly made the actual flowing of the solder on a full piece will take less than a minute, and will be so smooth as to require no other finish than the Scotch stone and the polishing wheels. After soldering, the cover should be placed upon the soldering pan (Fig. 1054) and the work allowed to become quite cold before removal; when a charcoal lump (Fig. 1033) or pumice stone is used the work must also be covered while cooling.

CHAPTER XII.

PRINCIPLES AND APPLIANCES OF SOLDERING.

SOLDERING is the union of two metallic surfaces, either by slightly fusing the surfaces themselves (technically termed sweating, or autogenous soldering), as in the union of a plate of silver to a block of copper preparatory to rolling into Sheffield plate, or by the fusion of an alloy which melts more readily than the metals to be soldered.

The conditions of successful soldering are as follows:—

1. Careful and proper investment. 2. Careful cleansing of surface on which the solder is to flow; which implies absence of oxid. 3. Careful application of the flux and of the solder. 4. Careful heating up. 5. Proper amount and direction of heat in flowing the solder. One condition requires good solder; of this we have elsewhere spoken. To limit the flow of the solder and protect all places which it should not encroach upon, a thin layer of plaster batter or a solution of whiting may be applied with a camel's-hair brush. Another calls for the use of borax, the specific action of which, as a flux, is—first, the removal of existing oxid by virtue of its powerful affinity for it; secondly, the prevention of further oxidation by the exclusion of the oxygen of the air. Another condition demands a skillful management of the blowpipe flame; this is the principal difficulty with most beginners and, indeed, with not a few old practitioners.

The borax (flux) should be used in the lump and rubbed with pure (distilled or rain) water upon a coarsely-ground *glass* slab until a creamy paste is formed. Into this the pieces of solder may be placed, and also some of it applied with a small brush or feather to the surfaces over which the solder is required to flow. Hard water and the common practice of rubbing borax on a slate make it impure and to some extent interfere with soldering. Too much borax is objectionable, and gold requires less than silver. The solder is placed along the base of the backing, and if this is short the solder can be directed in its flow by the flame of the blowpipe to the holes of the pins; if the backings are long, it may be best to place a small piece of solder over the holes of the pins in addition to the piece along the base of the backing. The solder should be tested before using by melting it on a piece of silver plate.

In fulfilling another condition—the management of the heat—the following points demand attention: (*a*) To raise the heat very gradually, until the water of crystallization of the borax is slowly driven off; for if this is done rapidly the borax puffs up and throws off the solder; rapid heating at the outset is apt also to crack the teeth. (*b*) To diffuse the heat when using the blowpipe, so that the solder shall not become melted before the metallic surfaces are hot enough to unite with it, else it will roll into a ball or flow with an abruptly-defined edge; whereas it should unite so smoothly with the plate that, except for the difference in color, its line of termination cannot be detected. (*c*) To manage the fine point of the blowpipe flame so as to be able to direct the flow of the solder to any given point; the rule being that, unless prevented, solder will flow toward the hottest point. There are two kinds of flame given by the blast of the blowpipe: 1. The broad, heating-up, or oxidizing flame; this is produced by holding the tip a little behind or at the edge of the flame. 2. The pointed, soldering, or deoxidizing flame; this is produced by passing the tip more or less into the flame. A very general mistake is to use too strong a blast.

The apparatus required for soldering includes a lamp to give a sufficiently hot flame; a blowpipe to give intensity and direction to the flame; borax, brush, glass, slate, solder, and solder-tongs; investing materials and clamps to protect the teeth, also to hold the parts in relation to each other until soldered; a receptacle to retain or give additional heat during the process of soldering; an acid (sulphuric) bath to remove the glass of borax.

As accidents sometimes occur from the flame communicating with the explosive mixture of air and alcoholic vapor in the body of the lamp, it is prudent to make a *safety lamp* by connecting the wick tube

with the body of the lamp by a small tube which shall be, under all circumstances, full of alcohol. Figs. 1034 and 1035 represent such lamps. If the wick is not permitted to run below the shoulder above the horizontal tube this tube will remain always filled with alcohol. The top of the wick tube should be beveled off in a direction just the reverse of that shown in the drawing, so as to permit the downward projection of the flame. Fig. 1036 is a very ingenious modification of the safety lamp, made by Dr. B. W. Franklin, so constructed as to retain the alcohol uniformly at the same level.

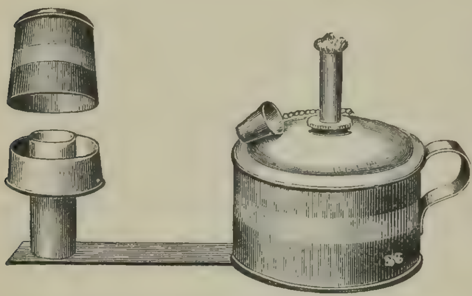


FIG. 1034.

The fluid used in these lamps is usually alcohol. For all purposes of dental soldering alcohol gives a sufficient degree of heat, and is much more cleanly than the carboniferous flame of ethereal oil, sperm oil, coal oil, or gas.

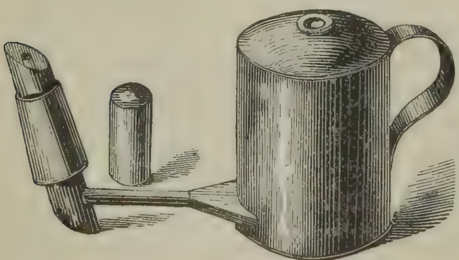


FIG. 1035.

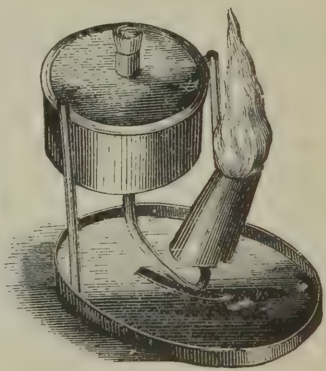


FIG. 1036.

To give intensity and proper direction to the heat of the lamp, a blowpipe is necessary. The simplest is a tapering tube, fifteen to eighteen inches long, and curved at the smaller end (Fig. 1037). At

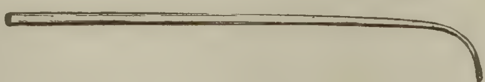


FIG. 1037.

this end the bore for the last half-inch should be *perfectly* cylindrical and about as large as a medium-sized knitting needle. This

may be modified in several ways and made more useful: First, by cutting it within three inches of the flame end and inserting a small, hollow ball or cylinder, to receive the condensed moisture, which, in the plain blowpipe, often interrupts the blast. Secondly, by attaching a flattened mouth-piece, which is much less fatiguing to the lips to grasp. Thirdly, by connecting the flame end to the mouth-

FIG. 1038.

piece by from six to twelve inches of flexible tubing. The flame end ought to be straight, and from four to six inches long; a cigar holder makes an excellent mouth-piece. A bulb or enlargement in the tube might be serviceable in retaining condensed moisture; but it is less liable to accumulate in rubber tubing than in the metal pipes. There are many forms of mouth blowpipes, and some quite expensive ones; but the pipe with flexible tube, as here described, will be found very convenient for the laboratory.

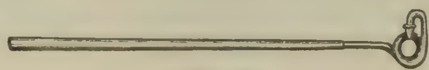


FIG. 1039.

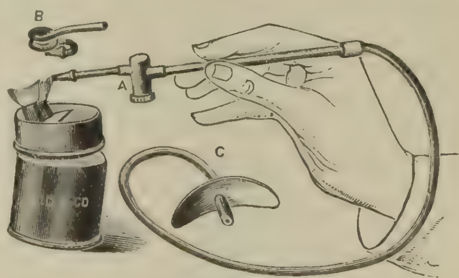


FIG. 1040.

Figs. 1038, 1039, and 1040 represent different forms of blowpipes devised for the purpose of preventing the moisture which accumulates within the tube from being blown from the orifice and interrupting the blast.

Figs. 1039 and 1040 are modifications introduced by Mr. Thomas Fletcher, and for the latter it is claimed that the mouth-piece is the easiest to use, and the heaviest continued blowing causes no strain on the lips, while the tongue has the necessary control over the opening. Being held as a pencil, the chamber on the stem stops all condensed moisture and prevents the heat ascending to the end.

The mouth blowpipe requires in its use a peculiar management of the muscles of the chest, cheeks, and palate, by virtue of which an

uninterrupted and regular current of air is thrown from the lungs through the pipe. The simplest way to learn how to do this is to first practice blowing exclusively during *in*spiration; this calls into action the cheek muscles and involuntarily closes the opening between mouth and fauces. Then use the pipe solely during *ex*piration; this teaches control of the chest muscles in the emission of a steady, gentle blast. The art of using the blowpipe without fatigue consists in alternating the action of these two sets of muscles; the art of giving a perfectly steady, uninterrupted blast implies control over these muscles and the ability to pass from one set to the other at the moment of opening or closing the entrance to the fauces. After persevering practice of the two methods of blowing, the art of connecting them will come almost unconsciously; when once learned it is never forgotten. Those who are too indolent to master the first difficulty of learning it become the slaves to mechanical appliances, which, however useful for many purposes, can never supply the place of this simplest and best of all blowpipes.

Blowpipes working by artificial blast may be divided into four classes: 1. Alcoholic or self-acting blowpipes; 2. Mechanical or bellows blowpipes; 3. Hydrostatic blowpipes; 4. Oxy-hydrogen or aero-hydrogen blowpipes. Of each of these we shall give an example. To enumerate all the forms that inventive talent has devised would fill too much of our space.

The SELF-ACTING blowpipes derive the force of their blast from the vapor of hot alcohol, which, igniting as it passes through the flame, adds to the intensity of the heat.

Small, portable lamps are made, of which quite a number of different patterns are to be found in the depots. The principle and general plan of construction are very clearly shown in Fig. 1041, designed by Dr. S. S. White. All alcoholic blowpipes give intensity of heat, but are greatly inferior to the mouth blowpipe in the control which the operator has over the force and direction of the jet.

The different forms of the MECHANICAL blowpipe are almost infinite. The principle of construction is either that of the bellows or the force pump, combined with a reservoir of air to give uniformity to the blast, which would otherwise issue in jets.

A common house bellows secured to the floor will form a simple and good arrangement. A spring should separate the handles, the upper one of which forms a treadle. An india-rubber pipe should pass from the nozzle to an air-tight box, from which a second tube comes out and is attached to the blowpipe. If the bellows is made double, like a blacksmith's, the upper half forms the air-chamber in place of the air-tight box.

Fig. 1042 represents the Burgess blowpipe, which is a convenient and efficient form. A is the cylinder of the pump, which is $2\frac{1}{2}$ inches in diameter, allowing a 3-inch stroke. B, piston rod. C is a heel-and-toe treadle for driving the pump. D, the receiver, 12 inches high by 3 inches in diameter, into which the air is forced. The whole height of the machine is 24 inches; the base is 12 inches by 5.

FIG. 1041.

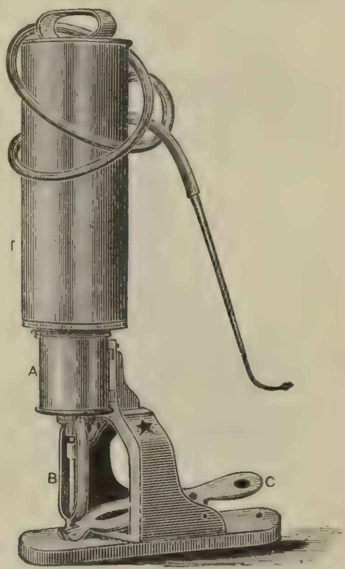


FIG. 1042.

Figs. 1043 and 1044 represent Fletcher's bellows blowpipes, capable of being adjusted in any desired position.

Figs. 1045 and 1046 represent two forms of the Fletcher automatic blowpipe, one of which is mounted on a ball-joint. These forms are

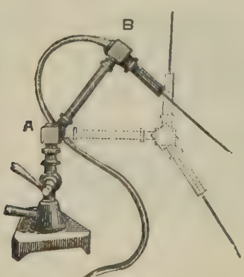


FIG. 1043.

FIG. 1044.

very convenient for soldering, especially in the manufacture of gold crowns and bridge-work.

Fig. 1047 represents a style of foot bellows by which the bellows and automatic blowpipes are operated. Fig. 1048 represents a carbon

block for use as a support in soldering. It is a perfect non-conductor and much cleaner than charcoal. Fig. 1049 represents a carbon cylinder, the cupped end of which answers as a good support for small cases, such as crowns, while soldering.

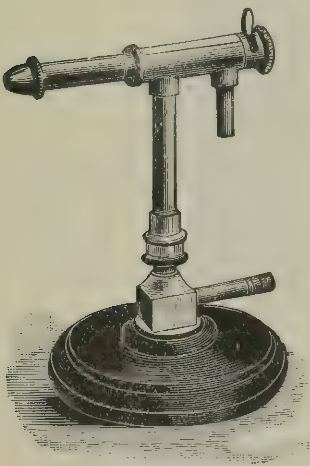


Fig. 1045.

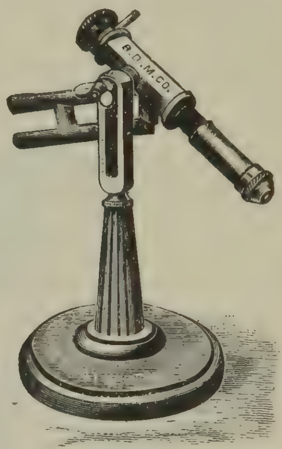


Fig. 1046.

Fig. 1050 represents Macomber's gas blowpipe. The direction of the point, 1, is regulated by the joint, 3, and the supply of gas controlled by the stopcock, 2. The air is supplied from the lungs,

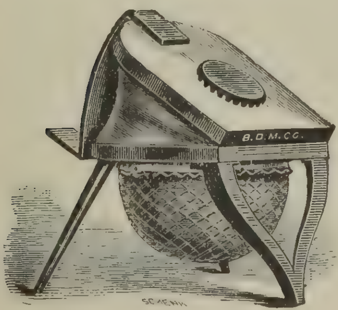


Fig. 1047.

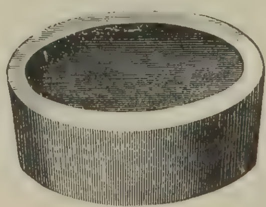


Fig. 1048.

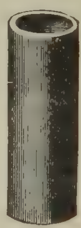


Fig. 1049.

or from some form of mechanical or hydrostatic blowpipe, through the flexible tube.

Fig. 1051 represents an automatic blowpipe to be worked by a foot-blower or bellows.

Fig. 1052 represents a hand blowpipe, into which the air is admitted at A and conducted through a small tube to the upper end

of the gas-pipe, B. The supply of both gas and air is regulated by pressure of the thumb or fingers on the rubber tubes, C. C.

The THIRD class of blowpipes is sometimes combined with the second to regulate the blast, or with the first to intensify it. In its uncombined form it consists essentially of a blowpipe point attached by a flexible tube to an air-chamber, from which the air is forced by the steady pressure of water. When once set in operation, it is self-acting, and in this respect has great advantage over the second class. This, with the perfect regularity of the blast, makes a properly constructed hydrostatic blowpipe much the best of all substitutes for the lungs and mouth blowpipe.

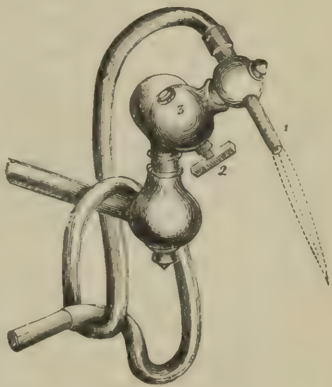


FIG. 1050.

The gasometer of the nitrous oxid gas apparatus makes a very excellent hydrostatic blowpipe. Its form, and the manner of using it, are so familiar to dentists as to render any illustration or description unnecessary. Any required force of

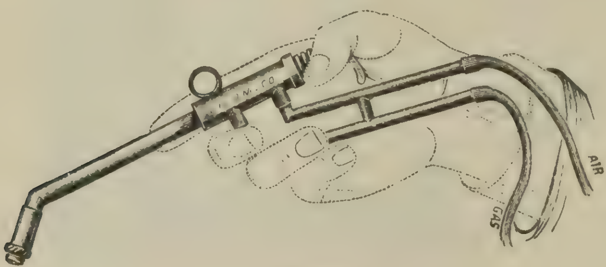


FIG. 1051.

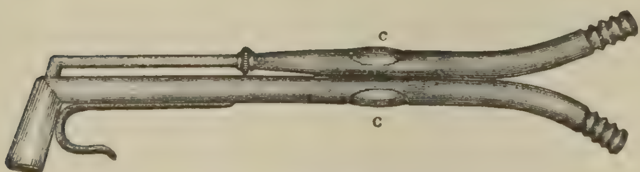


FIG. 1052.

blast may be given by detaching the counterpoise, or by adding weights to the descending cylinder.

The fourth class of blowpipes is analogous in its operation to the

oxy-hydrogen blowpipe. The point is double, consisting of a tube, through which comes the supporter of combustion (oxygen or common air), surrounded by a cylinder, through which comes the combustible (alcoholic vapor, illuminating gas, or hydrogen). In Count Richmont's aero-hydrogen blowpipe the hydrogen is generated in a vessel by the action of dilute sulphuric acid upon zinc, and the air forced through the center tube, either with a bellows or from the lungs. The heat is less intense than that of the oxy-hydrogen blowpipe, but is too great for most laboratory purposes. The gas blowpipe is a very convenient instrument; the principle is similar and the heat very great.

Fig. 1053 represents an ingenious oxy-hydrogen blowpipe invented

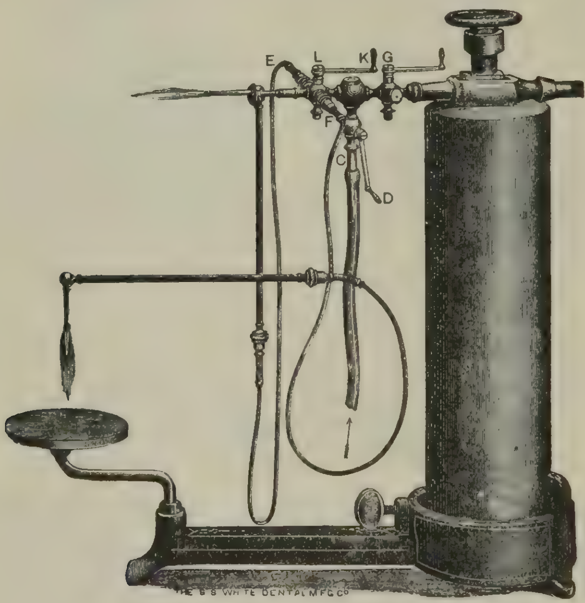


FIG. 1053.

by Dr. J. Rollo Knapp, which consists of an iron stand in which is secured, by a thumb-screw, a 100-gallon cylinder of nitrous oxid gas. By means of a yoke and set-screw the valve of the cylinder is connected with the tubes and valves of the blowpipe in such manner that the proportions of the mixture of nitrous oxid and illuminating gases are under perfect regulation and control.

There are two pipe-nozzles, which may be used at the same time, or one at a time, according as a large or small flame may be desired. One pipe-nozzle is shown as hung upon its hook, and the other as if directed upon work held on the pivoted bracket-table. It can be

used wherever illuminating gas is available. Any of the soldering operations of the laboratory, from the largest piece of crown-work to the most delicate joining of the narrowest bands or finest wires, are accomplished with equal facility. With illuminating gas of good quality and sufficient pressure a pennyweight of 20-carat gold can be melted in thirty seconds. A large investment must be heated first by other means.

The apparatus consists of the blowpipe attachments, connected to the yoke of a nitrous oxid gas-cylinder, the cylinder being set upright, and secured by a thumb-screw on one end of an iron base or stand, at the other end of which is pivoted a table upon which to rest the work. The blowpipe proper is a continuation of the outlet-tube of the gas-cylinder. A lever-valve, G, regulates the supply of nitrous oxid. Just beyond this valve is the mixing-chamber, K, to which the illuminating gas is conducted from the gas-bracket by means of rubber tubing, entering the bottom of the chamber through the valved tube, C. The lever, D, controls the supply. The mixing-chamber is provided with a gauze screen to prevent the flame from being drawn into the supply-tubes. Immediately beyond the mixing-chamber the pipe is branched to afford two flames of different sizes, E and F, which can be used independently of each other or both together. The valve-lever, L, regulates the flame in both. For greater convenience in manipulation the pipe-nozzles are connected with the branched pipe by rubber tubing. From the body of the valves, L, an arm extends, at the end of which is a small scalloped disk as a holder for the flame-nozzles when not in use. In the illustration one of the nozzles is shown in the holder, the other being directed to the revolving table.

In the operation of soldering the parts to be united must be held together in their exact relative positions. This can sometimes be done by simply laying them together; but usually they must be held in place, either by iron wire bound around them, or by small clamps of iron wire, or by rivets; or else by some investing material, which, in dentistry, is always plaster mixed with some substances that will counteract its tendency to shrink and crack under soldering heat. This substance may be coal ashes, soapstone dust, feldspar, clean sand, or asbestos. The two latter are the best, and may be mixed in proportions varying from 2 to 6 parts sand or asbestos to 4 of plaster. As a rule, the less plaster, the less shrinkage; but a very small quantity makes the investment too friable.

A common mistake is to use too large a quantity of investing material. This almost invariably results in the warping of the plate; for, as all investments have some degree of permanent contraction, and all metals must expand, if the latter is bound by a rigid, unyield-

ing mass it will inevitably warp. Hence, as a rule, use no more investing material than is necessary to keep the parts to be soldered in their position and to protect the porcelain surfaces from direct contact with the flame. This subject will be further considered when speaking of the soldering of teeth to the plate.

In selecting a suitable receptacle for the work to be soldered, it is important to retain the heat, especially when using the mouth blowpipe. A funnel-shaped mat made with scraps of woven iron wire, or a large lump of pumice stone, or one of close-grained charcoal, with the outside coated over with a thin layer of plaster, form very simple and convenient receptacles for smaller pieces of work. For larger work, or for very high temperatures, it is important to receive addi-

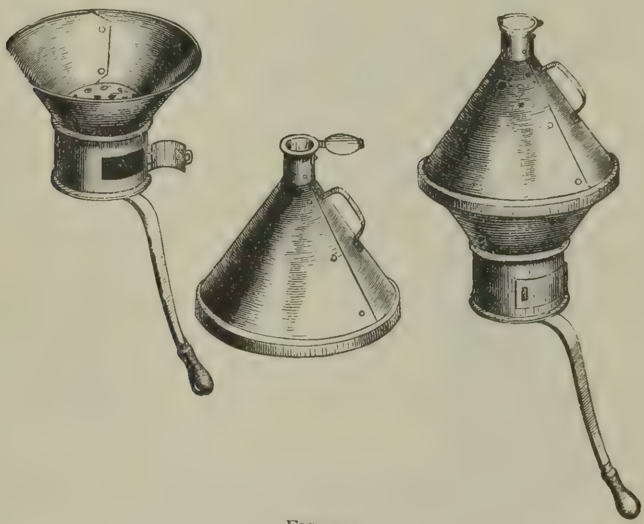


FIG. 1054.

tional heat from ignited charcoal, for which purpose the soldering pan (Fig. 1054) is a very admirable contrivance. The movable lid remains during the heating up and the cooling off,. but is, of course, removed during the act of soldering.

Fig. 1055 represents the form of soldering blocks which are made of either plumbago or asbestos.

After soldering the work should cool gradually, unless it is to be re-swaged. If there is any porcelain attached the cooling must be very gradual. When cold, it may be placed in dilute sulphuric acid and slowly raised to the boiling point, kept there for a few moments, and then slowly cooled. This dissolves the glass of borax, which is so hard that it injures the edge of files and scrapers.

A few general considerations may be of service in the use of the above-described appliances for soldering. It is an operation regarded by many as attended with much risk; and by students generally it is considered the *pons asinorum* of dentistry. Whereas, there is no process in dental prosthesis in which the desired result can be with more certainty obtained, provided such care and skill are exercised as alone can give success in any department of the art.

Plates warp from want of support when heated or from excess of investing batter; they are burnt, blistered, or melted from careless or ignorant use of the blowpipe. Teeth are broken from rapid heating or cooling; they are displaced by the shrinking of an ill-judged investment. Solder is condemned because it will not bridge a chasm one-eighth of an inch wide, will not run over plaster, will not attach itself to an oxidized surface, or will obstinately roll up into a ball rather than flow over a surface too cold to receive it. These and all other vexations of soldering are the result of haste, ignorance, or want of skill. If there should be spaces under the teeth or backings, which, however, should always be avoided if possible by adapting the teeth in grinding to the surface of the plate and having the backings of a proper length, such spaces should be filled with gold foil. As much of the surface of the plate should be exposed as can be done by trimming away the plaster without affecting the stability and safety of the teeth, so that no obstruction is present to the flame of the blowpipe; this direction is especially applicable to a lower denture either full or partial. Good soldering depends upon the perfect heating up of the investment and plate, so that the solder can be brought by the heat of the blowpipe flame as near the melting point of the plate as possible without injury to the latter.

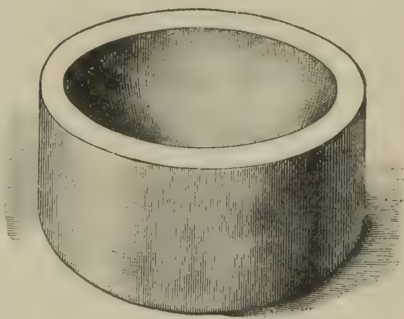


FIG. 1055.

In soldering two surfaces, as in the doubling of lower or shallow upper plates, the borax must contain no particles preventing contact of the plates; also the heat must be directed on the side opposite the pieces of solder. so that when melted it may flow between the plates from one side to the other. Clamps are preferable to plaster batter for holding parts together, whenever practicable, as in soldering a wire or band around plates; but when the relation must be preserved with utmost accuracy, as in clasps, the plaster investment is essential. It is

also necessary for the protection of porcelain from the direct action of flame.

In soldering teeth to a plate the batter must have such proportion of plaster with asbestos or sand as to admit of being used in small quantity, and yet be so strong when heated that it will not crack and endanger the position of the teeth. Backings and clasps must fit accurately wherever they are to be fastened. There should be no trace of plaster on a surface where solder is to flow; or, in fact, substances of any kind except borax, and not too much of that. Borax must be pure and clean, and used with soft water, and the heating must be gradual, in view of its liability to throw off the solder. Solder must be of good quality and carefully placed, never putting two pieces where the position will allow the proper quantity to lie in one piece. It is a very common practice to cut solder into very small pieces under the idea that it will flow more evenly; but if a plate is properly heated and the blowpipe flame skillfully managed the large pieces melt instantly and flow into their proper position.

It is quite possible, by careful observance of these directions and by expertness in the management of the blowpipe, to solder any set of teeth, bridge- or crown-piece, so that there shall be no roughness or abrupt edges requiring the use of files and scrapers. In fact, these tools are never needed to give finish to a perfectly soldered joint; the natural flow of the solder takes a shape which cannot be improved.

Finishing Process.—When the piece is cold it may be placed in water to soften the plastic investment, which should be carefully removed from the teeth; the set is then placed in a glass or porcelain vessel containing a mixture of equal parts of sulphuric acid and water, and heat applied. As soon as the borax (which, by the process of soldering, has lost its water of crystallization and assumed a glassy hardness) is decomposed, the vessel is removed and allowed slowly to cool. This process is termed by jewelers "pickling," and requires from ten minutes to half an hour for its completion, according to the strength of the acid and the quantity of vitrified borax on the plate. After this the acid is washed from the piece; or it is still more effectually deprived of acid by boiling in water containing a little caustic soda.

In removing the roughness which may have been occasioned by imperfect soldering, care must be taken not to cut away too much of the plate. For this purpose scrapers, files, and lathe burs are used, according to the position and quantity of surplus solder. Fig. 1056 represents a set of solder burs for trimming off superfluous solder. After the work has been made as smooth as possible with scrapers, etc., it should be rubbed with pieces of Scotch stone and water until

every scratch is removed; some use a fine, smooth cork attached to the lathe, and charged with water and powdered pumice or silex. The piece is then polished with Tripoli, applied by means of oil or tallow to a brush wheel (Fig. 1060), which is made to revolve rapidly

FIG. 1056.

against the work. Felt, rubber, walrus leather, and cotton wheels and cones are also employed in polishing. Fig. 1057 represents a felt wheel and cone. Fig. 1058 shows one of the various forms of vulcanite burs for carrying polishing powders. As to the rapidity with which a lathe should be worked: drills and burs require a slow move-

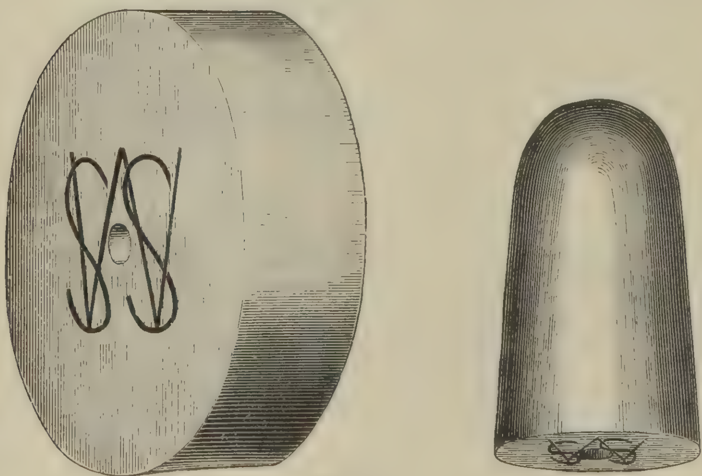


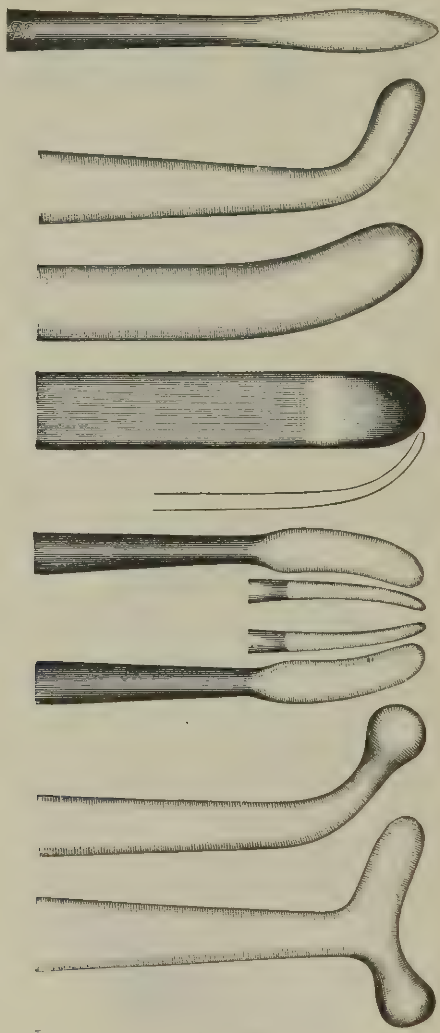
FIG. 1057.

ment; corundum wheels a quicker one; rotten stone a rapid motion; and whiting, zinc-white, or rouge the most rapid of all.

The piece may now be placed in a porcelain vessel containing the following mixture: niter, 2 ounces; salt and alum, each 1 ounce—

dissolved in 4 ounces of water. After boiling for half an hour in this to decompose the copper from the surface-layer of the solder and plate, it is boiled a few minutes in a solution of 1 ounce of caustic soda in 4

FIG. 1058.



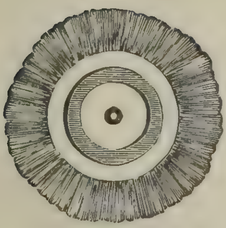


FIG. 1060.

FIG. 1059.

ounces of water to neutralize the acid, then washed with a brush in pure water.

The removal of the copper from the surface of the plate gives to the gold the beautiful orange hue, which is its natural color, and which it

will retain until the friction of mastication wears off this surface. The secretions of the mouth will fail to tarnish it; and it will be free from the disagreeable taste of which so many complain who wear artificial teeth set on metallic plate. But when plate is made from coin without alloy, or is 20-carats fineness, and the solder has a corresponding quality, the pickling process may be omitted.

The process of finishing is completed by polishing every part of the lingual surface of the plate, backings, and clasps with highly tempered and finely polished steel burnishers. Fig. 1059 represents various forms of plate burnishers. They should be frequently rubbed on a piece of wet Castile soap, and carried backward and forward in the same direction over the plate until every part of the gold exhibits a high polish. Burnishers of different shapes are required for different parts of the work; bloodstone burnishers are also used.

A piece, however, can be polished in less time, if not more perfectly, with brush wheels (Fig. 1060). Brush wheels vary in diameter, thickness, and material. Bristle wheels vary in stiffness and length of bristle; the stiffer being used for Tripoli or rotten stone, the softer for whiting and rouge. Cotton is often substituted for bristles; buckskin or felt are also much used for wheels or circular "laps," and are especially useful in dressing up the recesses of a plate. It is of the utmost importance that wheels or laps used for different polishing substances should be kept entirely separate; a little Tripoli or pumice powder on a rouge wheel may render useless the work of an hour. The brush should be set on the spindle of the lathe, then lightly smeared with suet by holding a small piece against it while it is revolving. The rotten stone is applied in the same manner, and with the brush thus charged, the polishing may commence; but the plate must not be exposed too long to the friction, as it will rapidly wear away the pure gold surface brought out by the pickle; hence some use only the burnisher or rouge after pickling. Tripoli has a sharper grit and cuts more rapidly than the ordinary rotten stone; but the latter gives a very smooth surface, and will in most cases give a sufficiently brilliant finish without rouge. A very high watch-case finish can only be given by very rapid revolution of wheels or buffers, charged with the finest quality of rouge, wet with alcohol. The piece must be previously washed with soap and water, so as to remove every trace of oil. Sometimes rouge is applied on a piece of soft buckskin, wrapped or sewed around small, blunt-pointed pieces of cork or wood. The lingual surface of the plate is the only one that should be polished. The dead color of the palatine surface throws out the polish of the other side and greatly improves the appearance of the piece. The adhesion of a plate is frequently improved by roughening the plate

with a file or by engraving lines upon it. The process of finishing on a gold piece, properly soldered, is a very simple matter, and one of secondary importance. A set with Scotch-stone finish is in every respect as useful and esthetically as beautiful as the most highly polished plate. There is, however, no objection to this sort of appeal to the eye, provided it is not the chief merit of the work.

There are three methods adopted for the retention of dental plates, and many modifications of form required by the various circumstances of different mouths. An enumeration of all the required forms would be impossible in this work; but we hope to represent a sufficient variety to enable the operator to decide which is best for any given case. We think it far more important, however, to endeavor to explain, as far as can be done, the principles which determine these different forms and modes of retention, than to lay down any set of didactic formulas for unreasoning adoption.

CHAPTER XIII.

RETENTION OF BASE PLATES—THEIR SIZE AND FORM OF OUTLINE.

The utility of a piece depends largely upon the firmness with which it keeps its place during mastication or in conversation. The means adopted to secure this are fourfold: The first two retain the plate by extrinsic support; the last two depend upon an intrinsic quality of the plate itself. 1. Spiral springs, by constant pressure, keep the plates of a double set in position. 2. Clasps, by grasping some natural tooth, hold a partial piece firmly in place. 3. Spring plates, which are constructed of vulcanized rubber, and are available only in partial cases. 4. The close adaptation of the plate, whether of a full or partial set, causes it to adhere with a force which is lessened, first, by the amount of air between the surfaces; secondly, by the liability to displacement. These modes of retention will be considered in the order named.

Fig. 1061.

Spiral springs, formerly very much used, are now seldom employed; they are applied only to double dentures. Fig. 1061 gives a correct

idea of the position of the springs, their points of attachment, length, and direction of curvature. Fig. 1062 represents the detached portions of the spring, consisting of standards, screws, tangs, and spiral coil. The tendency of the curved spring to straighten presses each plate upon the alveolus, acting at the points of attachment of the standards. These points are chosen, first, in the uppper jaw, as nearly as possible on the line of equipoise, which will be somewhere between the centers of the second bicuspid and of the first molar; secondly, in the lower jaw, where a vertical line from the upper standard meets it. Perforated bicuspids and molars are sold, adapted to such cases; and the usual plan is to attach the standards before soldering the teeth. A more accurate method is to determine the position of the standards after the pieces are finished. The presence of the teeth makes soldering of the standards more troublesome, but not impossible; they may also be riveted to the outer rim of the plate. With the diamond drill holes can be made through the teeth or blocks opposite each standard.

Directions for making the coil have already been given; they are

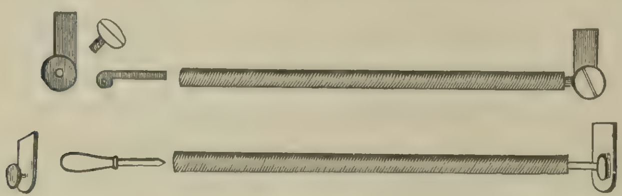


FIG. 1062.

usually purchased ready made. Their length must be such that the curve will not irritate the ascending ramus of the lower jaw. If too stiff their forcible pressure will irritate the gum; if too slight they will fail to keep up the piece. The tangs are held in the coil by closeness of fit; when loose they may be tightened by floss silk. The screws represented in the figure are troublesome to make, and are very apt to loosen. A better plan is, to pass a headed pin through standard, tang, and tooth, and rivet or solder it in the backing. This plan makes the tang permanent; the pieces are separated by detaching the upper or lower tangs from the coils. It adds greatly to the strength of the pin to pass it through the tooth or block. There should also be a shoulder on the standards to limit the movement of the tang; else the springs, by too great upward or downward motion, may irritate the mouth. It is unnecessary, in view of the present limited use of springs, to describe other and very ingenious methods of attaching them.

Dr. I. I. Stedman has devised a new form of springs for dental plates. Fig. 1063 represents the Stedman springs.

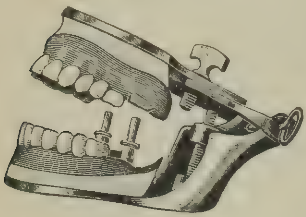


FIG. 1063.

The use of springs is now confined, first, to very flatly-arched upper jaws, usually small, covered with hard membrane, and having the attachment of the facial muscles close to, or quite upon, the ridge; also to lower cases where all trace of the ridge is gone. Secondly, to pieces inserted so soon after extraction that the rapid absorption will quickly destroy the adaptation. We shall speak elsewhere of other means adapted to meet these exigencies, in failure of which spiral springs are to be used. But they are troublesome to make, annoying to wear, diffcult to keep clean, and liable to accident; hence we only use them as a last resort. In conclusion, it should be noticed that the upper plate of spiral-spring pieces does not cover the palate, but is shaped more like the lower piece. This is one of its compensating advantages; for it is an objection to the otherwise valuable principle of atmospheric pressure that it covers so large a portion of the mucous surface.

CLASPS.

This method of retention, necessarily applicable only to partial pieces, has fallen into much disfavor, and given place to methods in lieu thereof which are really more objectionable. But, like many other time-honored practices which modern dentistry has thrown in its waste-basket, there are very decided advantages in this mode of retention, which make it in certain cases the best possible one. The disuse of clasps has grown out of, first, their injurious effects, due to improper construction and injudicious application; secondly, the difficulties of making a clasp piece. We venture the assertion that one-half the dentists do not really know how to make a perfectly adapted clasp piece; and that of the remaining half two-thirds will not take the trouble. The tediousness of clasp adjustment is out of place in that rapidity of manipulation demanded by the cheapness of modern dentistry. Nor can we expect to see the easily made but ineffectual vacuum cavity give place in turn to the clasp attachment, which it has to such an extent superseded, until the profession becomes awakened to the necessity of substituting good work for fast work—economical high-priced work for expensive low-priced work; until the mechanician so far respects himself as to value his labor more than the cost of his materials, and ceases to use certain substances because they are cheap, rather than others because they are better.

Next to pivoting, the clasp is the most secure of all methods of attaching artificial teeth in partial cases. But it is not universally applicable for reasons hereafter stated. In deciding upon the propriety of using clasps, the remaining teeth must be carefully examined to determine whether, in shape, position, texture, and relation to other teeth and to the proposed plates, there are many which admit of being clasped. If there are such teeth, a perfect impression of them is necessary; then greatest accuracy in fitting the clasp; lastly, a most exact adjustment of this to the plate, to which it is to be fastened with great care. Scrupulous observance of these points, in connection with a properly fitted and shaped plate, will take from clasp work the force of the objections urged against it.

In the selection of teeth to be clasped the points for consideration are: 1. Their condition: never clasp loose teeth or those where there is much alveolar absorption; or, if possible to avoid it, those which have filed surfaces. 2. Their shape: avoid all conical teeth, such as third molars and canines; also teeth considerably larger at the grinding surface than at the gum. The proper shape for clasping is the cylinder, or rounded prism; and only so much or such part of any tooth should be clasped as has this shape. Hence it is that thick, narrow clasps are best, because few teeth have much breadth of cylindrical shape. 3. Their position: incisors, canines, and third molars must be rejected for this reason; and second molars are unfit, if the plate holds incisor teeth. The incisors and cuspids are of all the teeth less suited for the attachment of a clasp. It is exceedingly difficult to apply clasps to these teeth in such a manner as to retain even a single tooth with sufficient stability to be worn with any degree of comfort. We remember once to have seen a case in which a central incisor (natural tooth) was inserted and kept in place by a gold wire projecting from each side of the tooth into holes drilled into the adjoining teeth. A stage of dental progress that permitted such a process might also have allowed the clasping of incisors; but we know of no possible circumstances that will justify, in the present state of dental art, the clasping of any of the six front teeth. No lower teeth should be clasped; but in some cases a stay (half-clasp) may be used. The best teeth, in respect of position, are the second bicuspids; next, the first molars; thirdly, the first bicuspids; and lastly, the second molars. These eight teeth are the only ones that should ever be clasped; and if possible the choice should be confined to the first four. 4. Their relation to the plate and to the other teeth. Let the clasped tooth be as near the line of equipoise as is consistent with other considerations. For incisors alone we should, for this reason, give preference to the first over the second bicuspids; and in case of

the loss of the ten or twelve anterior teeth we should use no clasp on the remaining molars. Teeth not decayed should never be separated from others with which they are in contact for the purpose of passing a clasp. If no other tooth can be found a stay (half-clasp) must suffice.

Observance of the conditions above enumerated restrict very much the range of cases that admit of clasps. In the matter of position and relation to the plate, circumstances may compel a choice not the most favorable to success; but in other respects it is far better to dispense with clasps than to apply them so as to incur risk of failure or injury to good teeth.

The liability to decay of the tooth around which a clasp is applied is always greatly increased by the removal of any portion of its enamel. The application of clasps to diseased or loose teeth always aggravates the morbid condition of the parts, and causes the substitute, which they keep in place, to become a sort of annoyance to the patient. Besides, such teeth can be retained in the mouth only for a short time, and when they give way the artificial appliance becomes comparatively or entirely useless; and even before their loss it is not held firmly in its place. Its instability exposes its presence to the observation of the most careless observer, and this motion is injurious to all the teeth near or against which the piece comes. In the lower jaw parts of sets are much less frequently called for than in the upper, and when they are, the use of clasps may be dispensed with altogether. A clasp can seldom be applied advantageously to a lower molar. The lower front teeth are least liable to decay of any in the mouth, and therefore do not require replacement, except in full sets, unless lost by a blow or by the destructive action of salivary calculus. A partial lower front piece calls for half-clasps or stays; but other partial lower pieces (replacing bicuspids and molars) should not depend for their stability upon any remaining bicuspid or cuspid.

If the injurious effects liable to result from the application of clasps to teeth selected according to the rules given could not in any way be counteracted, dental substitutes retained in the mouth by this means would, in the majority of cases, be productive of more injury than benefit; but they may be in great measure prevented. They are not caused, as many have erroneously supposed, solely by the mechanical action of the clasps upon the teeth, but also by the chemical action of the secretions of the mouth and decomposing particles of food. The method of measurably preventing these deleterious effects is twofold: First, to prevent the chemical action, the removal of the artificial teeth and thorough cleansing of them and the natural organs; this should be done every night and morning, and the teeth rubbed with a

brush and waxed floss silk until every particle of clammy, vitiated mucus and foreign matter is removed. The inner surface of the clasps should be freed from all impurities, and the whole piece cleansed with a brush and water. Secondly, to prevent or lessen the mechanical action the clasp should, as before remarked, fit with great accuracy the parts of the tooth protected with hard enamel; the whole piece should have such closeness of adaptation as to prevent motion of the clasp upon the tooth. We have elsewhere spoken of other injurious consequences of clasps placed too near the gums or exposed necks. Rapid decay and breaking off of the teeth, inflammation of the gums, of the peridental membrane, destruction of the alveoli and loosening of the teeth, are among the common results of the clasping of teeth as it is too often practiced. Consequences such as these have led many to an unqualified condemnation of this method; yet, as we have said, when suitable teeth are selected for clasping, and the work is properly executed, it is the best and most durable way in which a partial piece can be secured.

Shaping and Adjusting Clasps.—The gold employed for clasps should

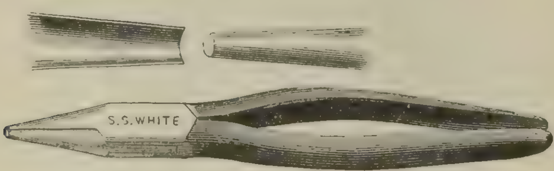


FIG. 1064.

be about one-third or one-half thicker than the plate, and as wide as the cylindrical portion of the crowns of the teeth to be fitted. Some clasps are best made of half-round wire, and narrow; others may be broader and thinner; thick, narrow clasps are more universally applicable. In quality it is better that clasp and plate be the same, except when the plate is of pure coin. In this case add copper (but no silver) to give elasticity. Platina, often used for this purpose, imparts too much brittleness, after the piece has been worn for some time. Some may fit the tooth close to the gum; but in other cases the shape of the tooth, absorption of the alveolus, or morbid sensitiveness of the neck, forbid this. Enamel surfaces best resist the wearing action of clasps; dentine, exposed by the file or chisel, is more liable to abrasion or decay; cementum should in no case be brought in contact with clasp or plate. If the clasps chafe against sensitive parts, inflammation of the peridental membrane may be set up, followed by wasting of their sockets and ultimate loss of the teeth. Fig. 1064 represents a clasp bender.

With the plate in position in the mouth, a wax impression may be taken; the plate, adhering to it, on being withdrawn, will have a correct relation to the teeth which are to be clasped. Others adopt the less accurate method of adjusting the plate to the original plaster model. But as, for reasons before given, it is advisable to cut off the teeth from the model used in molding, a second model is necessary, and usually for this purpose a second impression. Moreover, if the mouth has marked irregularities or rugæ, and the plate covers much surface, it cannot be fitted upon a plaster model so as to hold the same precise relation to the teeth as when in the mouth.

When accurately fitted, clasps may be at once soldered on the model, or may be attached to the plate by means of a small piece of wax or cement composed of one part wax and two of resin, or gum-shellac, or sealing-wax, or softened modeling composition; these should be softened or melted and applied to the plate and to the inner side of each clasp. The plate and clasps thus united are carefully removed from the plaster model and laid with the convex side downward on a piece of paper. Plaster is then poured on the upper side of the plate, covering it and the clasps to the thickness of half an inch. After this has set the piece may be taken from the paper, placed on charcoal, the wax being softened and removed, and prepared for soldering.

This is the simplest way of fitting clasps to the plate and preparing the piece for soldering. Fig. 1065 shows the usual form of clasp; but when the clasp teeth deviate from a vertical position, or when the teeth are of such a shape that the wax impression does not copy them accurately, this method is in such cases not reliable. The clasps must be fitted to the teeth in the mouth, instead of on the plaster model, and may then be attached to the plate as just directed. Often only one can be attached at a time, and after this has been soldered the piece is replaced in the mouth, and the other made fast to the plate. The greatest care is necessary to prevent altering the position of the clasp in taking the piece from the mouth.

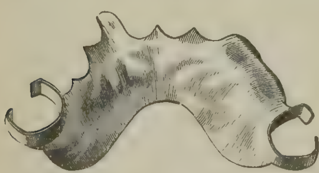


FIG. 1065.

The following is Dr. Fogle's method for securing accurate adaptation of the clasps. They are first fitted to the plaster model, leaving the ends straight. A narrow strip of plate about five-eighths of an inch in length is used as a temporary fastening, one end of which is soldered to the lingual surface of the clasp; the plate and clasp are now both placed on the model (made from impression taken while the plate is in the mouth), and the other end fitted and soldered to the

plate, forming a sort of semicircle or bow. Fig. 1066 represents the plate, clasps, and temporary fastenings on the plaster model.

The clasps are now adjusted to the model ; however accurately this is done, it will be found, on applying the plate to the mouth, that they will not fit the teeth there. After properly adjusting them the temporary fastenings will be found sufficient to hold the clasps in their exact position while the piece is being removed. This done, it may be invested, placed on charcoal, and the other steps connected with the process of permanent soldering gone through with, detaching the temporary fastenings when the investment has fixed the clasps in position.

Dr. Cushman advises, in very difficult cases of adjustment, as where the clasp teeth are much inclined, and where you have to fasten to second molars, a slight modification of this plan. After soldering one

FIG. 1066.

end of the strip to the clasp, and having bent the other to touch the plate when on the model, put both in their proper place in the mouth ; then, with a sharp-pointed instrument, indicate the point where the bow touches the plate ; place them on the model again ; adjust the end of the bow to the point marked ; confine it there and solder fast. Dr. Cushman considers Dr. Fogle's method of adjusting clasps so valuable that he never ventures to set clasps permanently, even in the simplest case, upon the original model with the plaster teeth as the only guide for position.

Dr. Lester Noble's method is as follows: Place the plate in the mouth, and let the clasp bind upon the tooth with only sufficient firmness to keep it in its proper place. Then mix a small quantity of plaster from a lot which, by previous trial, you find requires four or five minutes to set ; put it upon a piece of paper or sheet lead about

an inch square, and just before it begins to harden introduce it into the mouth upon the forefinger, pressing it into gentle contact with a portion of the plate and about one-half of the clasp. It must be held there for three or four minutes, until it is sufficiently hard to break with a sharp fracture; this point you can determine by examining the plaster left in your bowl. The plaster must then be withdrawn. Sometimes plate, clasp, and plaster will be brought away together; or the plaster and clasp together, leaving the plate; or the plaster will separate, leaving both clasp and plate in the mouth. Should the plaster by any accident break, it can readily be united at the point of the fracture, without in the least altering its shape—one great advantage over wax. If the plaster adheres to the plate on withdrawal from the mouth, it must then be carefully detached, the plate replaced, and the same process repeated for the second clasp; or possibly the impressions for both clasps can be taken at once.

Several precautions are necessary. If the clasp bind too tightly around the tooth its ends will when removed spring together; and thus it will not exactly fill the original impression made in the plaster. If the part of the clasp which you design to cover with plaster be so regular in shape as to make its adjustment when out of the mouth uncertain, mark it with a file or a small point of solder; this will be copied in the plaster, and remove all doubt as to its definite position. If the plaster be extended over some part of the edge of the plate, it will, in the absence of any marked irregularities of surface, give a better guide for its readaptation. Lastly, if the plaster cover too much of the clasp tooth, it will be more liable to break on being withdrawn.

Take now the clasps, place them each in their separate impressions in the pieces of plaster, securing them if necessary by a small piece of softened wax. Place one end of your plate in its corresponding bed in one of the plaster pieces. If proper care has been used, both clasp and plate will fit into the plaster with unerring accuracy, and, of course, hold the precise relation as when in the mouth. While in this position cover the clasp and the under surface of the plate with fresh plaster, or plaster and sand or asbestos; when this has hardened remove the first plaster, just as in other cases you would remove the wax, preparatory to soldering.

The methods of Drs. Fogle and Noble may be thought too tedious for cases where the shape and position of the teeth are such that a wax impression will accurately copy them; but in the great majority of cases it will be found essential to accurate adjustment to resort to one or other of them. Sealing-wax or shellac may also be used to retain the clasps in position until they are soldered to the plate.

If the clasp stands off from the tooth on its coronal edge, the food

is apt to pack into the wedge-shaped space and loosen it, or even change its shape; if on the edge near the gum, it gives lodgment to the food and mucous secretions, to the injury of the tooth. Dr. Spalding recommends, as a preventive against such lodgment, to use in all cases thick, narrow clasps; to attach them by two or more standards (Fig. 1067), if the clasp is long; to put them well up on long teeth, and on short teeth to cut away the plate. In this way most of the neck is exposed to the cleansing action of the tongue.

The close adaptation of the clasp to the surface of the tooth is too often neglected. It is commonly done with round pliers, making trial from time to time upon the tooth of the model. This is an uncertain method in any case, and in many utterly worthless. Prof. Austen advised always to take a separate plaster impression of the teeth to be clasped; for which purpose a small partial impression tray is used (Figs. 939 and 940). Let the plaster get quite hard; then slightly open the impression; withdraw it and close up the fissure. Make from this either a plaster or a fusible-metal tooth; if the former, harden it with soluble glass. With round pliers and a hammer clasps can be fitted with great exactness to such a metallic tooth. Extreme accuracy of fit may most easily be obtained when the contour of the tooth is irregular by the following method: burnish down to the tooth a strip of very thin platina; then on the outside of this strip lay pieces of gold (of the fineness suitable for clasps), with borax, and flow them with the blowpipe.

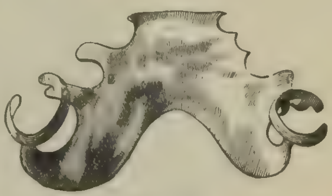


FIG. 1067.

A common error in soldering clasps is to make their union to the plates too wide. Clasps are often called springs, but if soldered through nearly their whole length they become rigid stays, devoid of elasticity. Fig. 1068 shows the proper extent of clasps embracing the posterior natural teeth. There should always be a proportion between the size of the clasp and the width of its attachment; in no case should it exceed three-sixteenths of an inch, and one-eighth of an inch is ample for most cases. When practicable the two arms of a clasp should be of equal length; but in short clasps it is sometimes preferable to throw all the elasticity into a single arm. A single attachment is better than two, as it gives more play to the arms of the clasp in the slight unavoidable motions of the plate. Again, in shaping the plate, cut it well off from the tooth, allowing a tapering tongue to extend up the clasp for its attachment. In clasp pieces and in all partial pieces remember that the plate should come in contact with the

teeth it approaches, or else stand as far off as the case will permit; the narrow band of gum so often left between plate and teeth is liable to irritation by compression between the two; this is productive of more annoyance and injury than the direct contact of the plate against the tooth.

Partial Clasps or Stays.—These differ from clasps in the absence of elastic arms grasping the tooth. Taking a short, rounded prism (triangular in case of bicuspids, in molars quadrangular) as the "type" of a clasp tooth, the clasp proper must grasp a side and two angles or two sides and three angles. If it lies against two sides and one angle, or if two opposite sides are so inclined (in the line of the clasp) that it will not take hold, then it becomes merely a stay (Fig. 1069).

Stays demand for serviceable action a *point d'appui;* hence they must be in pairs—lying either against the two teeth bounding an

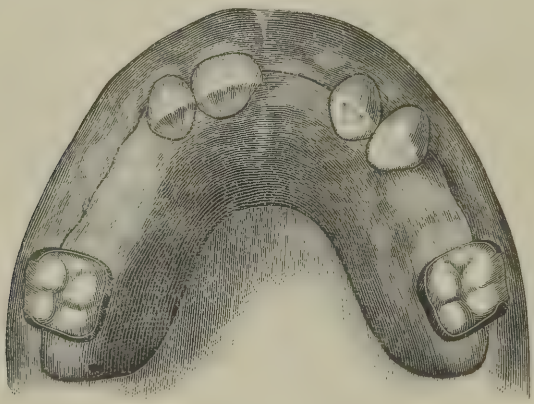


FIG. 1068.

interdental space, or against teeth on opposite sides of the mouth. They have great value in all partial cases where there are no isolated teeth suitable for clasps. Their function is to give stability to the plate by preventing lateral motion. When the bicuspids or molars have inclined or bulging inner surfaces the stays hold the piece after the manner of a clasp, the elastic force being given by the plate. This result can only be obtained, however, by a very carefully taken plaster impression when a vulcanite plate is made, or in case of gold plate by getting the exact relation of the parts by Dr. Noble's method. It is a mistake to attempt forcible retention of a plate by the lateral thrust of stays; any such pressure causes the teeth to yield, and then the stays can only act as in the cases first given.

It will be observed that when the stay on each side is double, as in

Fig. 1070, it not only prevents lateral motion, but the points between the teeth prevent backward motion. The stability given in this manner by stays, taken with an exact adaptation of the plate, is far more trustworthy than that given by any form of vacuum cavity.

In connection with clasps we shall briefly notice two methods occasionally practiced for the retention of plates. First, by the pressure of wood against the tooth. This method was formerly much used when human or ivory teeth were set on bone. Stays were carved in bone (see Fig. 1070); or metallic stays or clasps were riveted, or grooves and cavities were cut, holding slips of some hard wood which pressed against the teeth. This method was applied by Dr. Stokes to metallic plates—soldering gold tubes to the plate near the teeth so that the end of the inserted wooden pivot, slightly projecting, pressed on each side of the tooth selected.

Seeondly, by drilling into one or two sound roots of incisors, canines, or bicuspids a short canal, and lining it with a gold tube. Corresponding pins soldered to the plate keep it in place much as stays do; if the roots permit deep canals they may retain it with consider-

FIG. 1069.

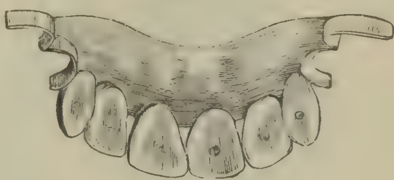


FIG. 1070.

able force. Such a pin may be used in combination with a clasp or stay. Directions given in chapter on crown and bridge-work easily explain how to prepare and attach such pins. In some cases it may be desirable to use such a pin in place of a clasp or stay, but the plate must cover enough mucous surface to give stability. We question the propriety of subjecting the roots of two incisors to the strain of five or six teeth on a plate of this kind.

When the teeth have recently been extracted and it is designed to construct an artificial denture before much change has occurred from absorption, the front portion of the plate should terminate within the outer border of the alveolar ridge, and the edge be scalloped to correspond with the festooned surface of the gum over the cavities from which the natural teeth have been removed.

Size and Outline Form of Special Cases.—It is impossible to enumerate all varieties of clasp pieces, nor could we delineate under each variety any one form as absolutely best for all its sub-varieties. The more philosophical course is to find if possible what principles,

mechanical and physiological, determine the best form in any case, and to illustrate by a few examples the application of these principles.

Upper Incisors.—The plate must not cover the front of the alveolus, so that on front or side views of the mouth its presence can be detected. This rule applies also to canines and front edges of bicuspids. The model at these points should be scraped, so that the corresponding die shall give a shape which will sink into the gum. The plate must also be filed to a thin edge before grinding the tooth. With these precautions a tooth or block may have the support of the plate under the center of its base. Otherwise it becomes necessary to cut the plate along the line of the backings; and this is in some cases the best plan. Incisor teeth, if firmly bedded in the gum, may trust for stability to their hold in the standards, provided they have been properly fitted and soldered.

The size and shape of plate between teeth and clasps will depend upon the number of incisors, position of clasps, presence or absence

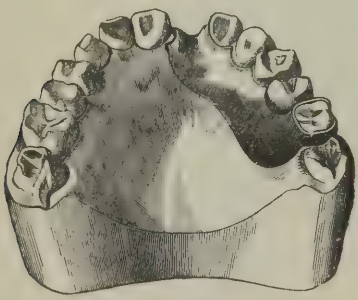


FIG. 1071.

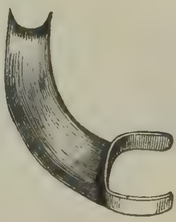


FIG. 1072.

of other teeth, and upon peculiarities of the mouth or of the patient. For the application of the principles already given to these several conditions we shall select a few particular cases.

One Incisor.—A central or lateral should not be attached to a first molar on the same side by a plate clasped as in Fig. 1072 without an additional clasp or partial stay around one of the bicuspids, as in Fig. 1071, in order that the leverage between the clasped and supporting tooth or teeth may be lessened. It is also desirable to have the plate extend some distance back of the tooth around which the clasp passes. When three or more natural teeth intervene between the clasp and artificial teeth the latter form is preferable, because there is no possibility of irritating the teeth by the plate or by mucous deposits. It will be noticed that the curve of the plate is opposite that of the dental arch, thus giving proximity to the teeth only where it is unavoidable. A lateral incisor, cuspid, or bicuspid may be applied in the same way;

and if the second bicuspid or first molar is unfit, from its shape and from decay, to be clasped, the plate may be extended to the second molar, or it may be even carried across the mouth and clasped to a plate on the opposite side; but these modifications are suggested only in cases of necessity. Such plates may be made very narrow if strength is given by increased thickness; but too narrow plates are open to the objection of allowing the attached tooth to bed itself too deeply under the pressure of mastication. When the form in Fig. 1071 is adopted it is usual to direct soldering a wire or band along the festooned edge to give strength. A much better plan is to gain strength by thickness of plate, and to chamfer the plate along this edge. The thin edge protects the gum equally well, does not wear the teeth more than the thick one, and has the decided advantage of giving no space for lodgment of food.

This plate will permit attachment of clasp to the molar and to either of the bicuspids, accordingly as one or other of these may be best for clasping. Decision in this case is based on principles which apply to many other cases. Supposing the three teeth well shaped and sound, the molar is firmly implanted by its trifid root, and permits complete encircling with the clasp; but it is further from the incisor; hence there is more strain upon tooth and clasp. With the clasp to the second bicuspid, the plate having the same length as before, we have the best possible application of its retentive power; it cannot, however, pass around the outside or front angle of either bicuspid, consequently the clasp does not have so firm a hold on the tooth. The same remarks apply with even more force to the first bicuspid. There will usually be some modifying circumstances to determine in this class of cases choice of the clasp tooth.

Two or Four Incisors.—Two incisors may be attached to a plate shaped as for one (Fig. 1071), with the addition of a second clasp, or partial stay, when the teeth will not permit of a full clasp. But much the best practice is to select the second tooth on the opposite side. Fig. 1073 gives the form when it is decided to run the plate up to the intervening teeth. With four incisors and clasps on second bicuspids, the form represented by Fig. 1073 is best, because only two teeth lie between the incisors and clasp; and it is better to carry the plate up to the teeth than to expose so small a portion of gum. For four teeth the plate should be rather wider than for two.

In these cases a closely-fitting plate assists so much in its own retention that bicuspid stays will often suffice to retain them, or a clasp on one side and a stay on the other. When the adhesion of the plate to the gum is thus partly relied upon it is not necessary to make the plate for four incisors larger than in Fig. 1073.

When the four incisors and the cuspids are to be replaced the construction of the plate (Fig. 1073) is upon precisely the same principle as the preceding, the only difference being that the plate should be rather larger and extend further back than the clasped teeth. When the teeth on one side of the mouth are too much decayed, or are incapable of affording a secure attachment, or are missing, even this num-

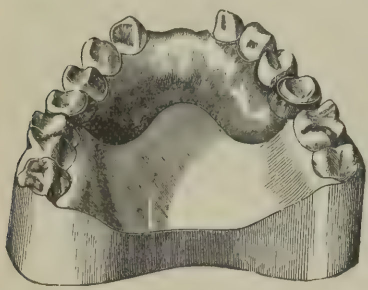


FIG. 1073.

FIG. 1074.

ber of teeth may be held by a double clasp on one side of the mouth and a stay on the other. But the plate should be extended half or three-fourths of an inch back of the tooth to which it is clasped. If this precaution is neglected, the piece, from its weight, may act as a lever upon the tooth and loosen it or cause periostitis. It sometimes happens that a piece made originally with clasps on both sides of the mouth loses the benefit of one clasp from the loss of the tooth; and yet the patient retains it in place as well as before. The piece is then in part retained by the fit of the plate to the gum; from which we learn that if only one clasp or, what is better, a double clasp can be attached to a plate with from four to six teeth, it is advisable to cover rather more of the surface of the mouth. In this combination the clasp and stay gives steadiness, and the close fit of the plate to the gum gives adhesion.

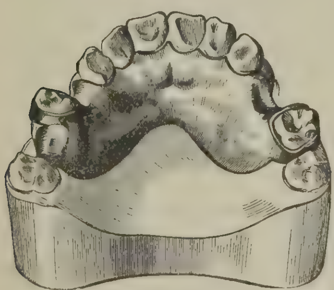


FIG. 1075.

Upper Bicuspids.—One or two bicuspids on one side are often attached to a plate about the size of a half dollar, clasped to the bicuspid or molar behind. But such pieces are not of much service in mastication. It is better practice to leave such a space unfilled than endanger the durability of a good tooth by clasping it. If there is a bicuspid space on either side the plate crosses the mouth. Fig. 1075

represents such a plate clasped to the first molars and fitted, as is very commonly done, closely to the incisors. But in this and all other cases where the four or six front teeth remain, if the plate does not fit closely to the palatal necks of the natural teeth, it is decidedly better to leave as large a space between the plate and the teeth as possible. The strength of the plate is preserved by giving less curve to the back edge, or by doubling the plate in the middle. The design of this form is to leave uncovered as much of the roof of the mouth as is possible.

An important point is gained by having the plate fit closely to the teeth and mucous membrane immediately back of the natural front teeth, and also by having the edge of the plate made thin. The articulation of the dental letters (the mutes T, D, Th, the nasal N and the liquid L) is thickened by a plate which is left thick at such a part, or not well adapted to the mucous membrane and the teeth.

When the loss of bicuspids is accompanied by that of the six front teeth, and the first molars alone remain, a good form of plate is shown in Fig. 1074. The backward extension of the plate, curving partly over the alveolus, is designed to prevent the weight of the piece from acting injuriously on the molars and to assist their retentive power. If the second molars are also in the mouth, the extended plate must be differently shaped. If the molars are well shaped and firm the plate may be narrower than here represented, being careful to make it thicker also. But if the presence of adjacent molars prevents the use of complete clasps, or if their form renders stays necessary instead of clasps, the plate may be rather wider. Be careful, however, not to cover the hard floor of the palate, or to attempt giving, by a cross band at the back of the plate, the stiffness which is best gained by thickness of metal.

Plates of this class are kept in place as much by the adhesion of contact with the gum as by the clasps. In many cases the force of adhesion is such that the lateral support of stays is quite as effectual as clasps. Hence, after a clasp piece of this kind has been worn for some time and become perfectly set to the mouth, it may be advisable to shorten the clasps into stays; indeed, it is better practice, in all cases, to anticipate this ultimate fit of these plates and make stays at first instead of clasps. This applies with still more force to the loss of twelve teeth, the second molars remaining, which should in no case be clasped; stays may very properly be used to prevent lateral or backward motion of the plate. The presence of these second molars, by giving lateral steadiness to the plate, prevents all necessity for covering the hard palate, and makes a vacuum cavity wholly uncalled for. A solitary molar should never be clasped, nor should it be allowed to remain in the mouth.

Alternate Spaces.—It remains to consider the forms of plates for vacancies alternating with natural teeth. The forms given for four incisors will answer for all alternating vacancies anterior to the second bicuspids, remembering to make the plate wider in proportion to the number of teeth, and thicker in proportion as it is made narrow; also, that a first bicuspid may in many of these cases be clasped with better effect than a second or than the first molar. Fig. 1076 is a good type for cases where the vacancies include the bicuspids; notice in this cut the backward extension of the plate. Where the natural teeth are in groups of two, it is best to carry the plate close up; if as many as three or four are together, the plate may be cut away, especially if they are incisors. Fig. 1077 represents an exceptional case, in which two laterals and two left bicuspids are attached by clasping to the right first bicuspid and molar. The left molars are supposed to be loose, or sockets much absorbed, or from some other cause forbidding

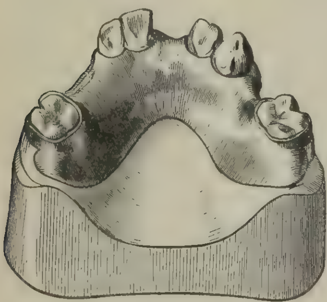


FIG. 1076.

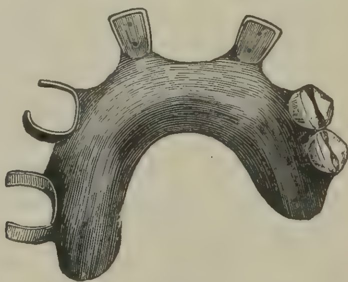


FIG. 1077.

clasps or stays. In this case the undue strain on the clasp teeth will ultimately cause their loss. Whenever an unavoidable strain of this kind is thrown upon a tooth a clasp may be used in preference to covering the palate, provided the patient is content, for the sake of the firmness which it gives, to risk the loss of the tooth. Teeth are more firmly retained by clasps than by atmospheric pressure, and this, with many patients, outweighs all considerations of injury to the other teeth.

Partial pieces with alternating spaces do not acquire that adhesion by contact found in cases where the lost teeth lie together. The interrupted margin between the teeth so readily admits air under the plate on the slightest motion that the atmospheric pressure is imperfectly applied. Hence there is continued demand for the retentive power of the clasps. The vacuum cavity does not correct this difficulty or supply the place of clasps, since, as will be explained in the

next section, the vacuum acts on soft membrane and has necessarily a temporary force.

When the six or eight front teeth remain, a plate holding bicuspids and molars cannot be retained by clasps. In the first place the cuspids could not be clasped, nor would it be proper even to carry stays against them. In the latter case the weight and leverage of the piece would be too great for the slight clasp that a first bicuspid permits; but two stays, with the points passing as far to the front of the bicuspids as the cuspids allow, would tend to prevent the slipping of the plate backward.

Lower Partial Pieces.—These do not properly come under the head of clasp work. Fig. 1078 represents a reinforced partial lower plate for supplying bicuspid and molar teeth on both sides, the six anterior natural teeth remaining in the mouth. The anterior portion of the plate is extended upward on the lingual surface of the natural teeth, which adds to the strength and acts as partial stays for the retention of such dentures. Additional strength may also be given by doubling the anterior portion of such a plate. In replacing one or more incisors lost by accident or calcic deposits half clasps may be applied to the bicuspids. For such cases the best style of work, beyond all question, is a vulcanite plate, made on a model from a plaster impression. Fitting with great accuracy the inner surfaces of the bicuspids, it is firmly held without injury to the retaining teeth. Partial pieces filling bicuspid and molar vacancies should not clasp cuspids or bicuspids; the position of remaining molars seldom permits clasping; even stays cannot always be applied. Artificial crowns may be inserted to support a clasped plate and gold crowns may be attached to roots and badly decayed teeth to support clasped plates, and thus save more valuable teeth from the strain and wear of clasps.

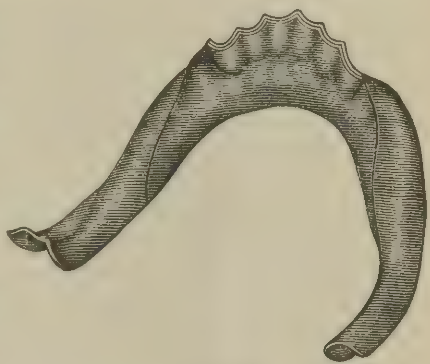


FIG. 1078.

In chapter fourth, on Preparatory Treatment of the Mouth, the question of extracting molar or bicuspid teeth which might otherwise be used for clasping is considered. The importance of permanence of the work outweighs any temporary advantage resulting from clasping one or two such teeth. In chapter third, and in the section on Retention by Clasps, are many remarks which it is unnecessary to

repeat, but which are important for the full understanding of the details of construction given in this section.

PLATES RETAINED BY ATMOSPHERIC PRESSURE.

Of the two methods of retaining a dental appliance already considered, the first, by springs, is suited only to entire dentures; the second, by clasps, is adapted only to partial cases. The principle of retention now to be considered is applicable to both; where practicable it is the most perfect way of retaining a set of artificial teeth. If the pressure of the atmosphere could be removed from the mucous side of a plate, allowing its full force to be exerted upon the lingual surface, the smallest plates would adhere with a force of four pounds, the largest forty. But, for reasons to be given, plates seldom have one-fourth of this resistance to displacement. There are two methods in present use for securing the service of atmospheric pressure. One is by close adaptation of the plate; the other by construction of a cavity of definite form. Both act by the more or less perfect exclusion of air from between the plate and the mouth. The first will be considered as the Adhesion of Contact; the second as the power of the Vacuum Cavity. Before describing the separate application of these to dental plates, a few remarks are necessary in addition to what has already been said in the last section of the third chapter, in exposition of the general principles of atmospheric pressure.

The surfaces of two pieces of highly polished ground glass, if pressed together, will adhere firmly; so much so, sometimes, as to resist every attempt at separation. Surfaces less smooth and close-grained will also adhere with great tenacity if their pores or irregularities are filled by wetting with water. If both surfaces are rigid they may be made to slide upon each other, but will resist a force of five to fifteen pounds for every square inch if applied at right angles to the surface; if one surface is soft and pliant it becomes difficult to keep it in contact around the edges. Traction upon the center, as in the case of a disk of wet leather upon a flat stone, will draw in the edges and create a vacuum in the centre. It might be supposed that in this vacuum space lies the power that raises the stone; whereas it lessens the power by reducing the area of stone in contact with the leather, even if the vacuum is perfect. Still, if the entire circumference is in contact no air enters the cavity except what passes through the porous leather, and for a time the lifting power of the disk is sufficient to raise the stone. If traction be made upon the disk anywhere but in the center the flexible edge will be raised; air enters between the surfaces and counteracts that pressure on the under side of the stone which was the lifting force.

Hence between two surfaces adhering by simple contact, one of which is soft and pliant, adhesion is not so persistent as where both are rigid, because of the liability to separation around the edges admitting air between the surfaces. Applying this to dental plates we may understand their liability to become detached by a degree of motion which separates them from the gum at any one point around the edge. We learn also that so long as absolute contact is maintained we have the most perfect exclusion of air practicable; hence no force of adhesion in a limited vacuum cavity (the perfect exhaustion of which is impossible) is comparable to the adhesion of the entire surface of the plate, provided this is made as perfect as possible by accurate workmanship and is not weakened by the admission of air around the edges.

If we exhaust the air from the barrel of a key and apply the lip, it will be drawn in and held with a force sufficient to support the weight of the key for some time. This simple experiment will prove, on examination, very instructive. The mucous and submucous tissues are pressed into the key because the fluids pervading these parts, being under pressure in every other direction, tend toward the point from which the pressure is wholly or partially removed. The extent to which the lip is drawn into the key will depend upon two conditions: *First*, the softness and mobility of the tissue; *secondly*, the shape of the edge of the orifice. If in addition to these two points we inquire, *thirdly*, why the key after a time drops off, we shall, from this simple illustration, have fully explained the rationale of the vacuum cavity, as applied for the retention of a piece of dental mechanism.

First: the extent to which or rapidity with which a partial vacuum becomes filled up by any yielding tissue with which it is brought in contact depends upon the mobility of its structure. We say partial vacuum, because the process of mechanical exhaustion can never produce a perfect vacuum. If the water which gives softness to mucous tissues was perfectly free to move, the cavity would be instantly filled, however deep. Parts as mobile as the tongue and lips yield readily to this fluid pressure; but the mucous membrane of the alveolar ridge and palate, being more or less tied down to the bone, fills the cavity more slowly; if too deep it will not fill it at all, except by hypertrophy. Reverting to the experiment of the key: if violent suction is made a purple spot is left upon the lip; the mucous tissues being prevented by their structure from filling the vacuum, the fluids still feel the impulse of atmospheric pressure; the blood, thus impelled with a force which the thin capillary walls cannot resist, is extravasated, as takes place also in the application of "dry cups." Hence,

where a dental-plate cavity is so deep that the tissues cannot fill it, if the degree of exhaustion is such as still to draw upon the surface, the tissues are in danger of being ruptured. Such a source of irritation will in many persons develop morbid action and should forbid the use of deep cavities in any plate.

Secondly: The shape of the edge modifies the rapidity with which the cavity fills. If the edge of a cupping glass is rounded the skin glides under it and is drawn from the adjoining parts into the glass; but if the glass is ground so as to present a sharp edge on the inside, this beds itself in the surface and prevents so much of the adjacent skin from being drawn in. It rises to a less height in the cup, and the remaining force of the vacuum is spent upon the capillary vessels, which are ruptured. Hence we learn that sharp-edged cavities fill less rapidly, but act with more power upon the tissues; they are consequently more apt to excite disease if the cavity has sufficient depth to allow continued action.

Thirdly: As to the cause of the final dropping off of the key: water and all the moist tissues of the body contain atmospheric air which they yield up under a vacuum. Hence a mucous membrane, although at first drawn strongly into a cavity, will make the vacuum less complete by giving out of the air contained in its tissue and in the blood constantly circulating through it. The adhesion of a vacuum, therefore, over mucous membranes requires renewal by occasional suction, since the blood is constantly circulating through the surface and supplies air to the cavity. Mucous membranes have also the property of *absorbing* air, as is seen in the lining of the bronchial cells constantly and in the power of the mucous membrane of the intestines to absorb the gases there generated. This property acts an important part in absorbing small quantities of air unavoidably caught between the plate and the mouth; thus partly explaining the well-known fact that plates adhering by simple contact become tighter after being worn awhile.

Thus the double action of mucous membrane, absorbing minute portions of air pressed against it, and giving out its contained air to a vacuum, favors the retention of simple contact, whilst it acts against the efficacy of the vacuum. In either case it prevents the full force of pressure theoretically possible. The practical inference from the lesson of the key is that the Vacuum Cavity acts well at first, and may be useful for the temporary purpose of retaining a plate until the changes of which the mouth is capable adapt it more perfectly to the plate; but for permanent adhesion the only reliable application of the atmospheric-pressure principle is the Adhesion of Contact, which is fully developed only when the contact of the plate is complete. A vacuum

cavity, acting as such, gradually draws the gum into it and finally fills it by a more or less permanent enlargement; when thus filled the plate is retained solely by the adhesion of contact. When a cavity intended to hold up a plate leaves no prominence or mark in the mouth, it unmistakably proves that it is exerting no force; so far from aiding in the retention of the plate it diminishes the force of adhesion by the presence of air, and has no compensating advantage except in removing pressure from a hard palate membrane. There are, however, other and better ways of obtaining an air space, as elsewhere explained, without the presence of a cavity, which marks the failure of its original purpose.

ADHESION OF CONTACT.

Full plates, which are designed to adhere by force of contact, differ from those retained by spiral springs in that the former are larger than the latter, covering more of the palate, so as to give a larger surface for the pressure of the atmosphere. They may cover the whole of the outer surface of the alveolar ridge and a considerable portion of the roof of the mouth; but should not go as far back nor run so high up as some dentists are in the habit of extending them. If allowed to cover those parts of the bone where the cheek muscles on the outside of the ridge or the palate muscles at the back of mouth are inserted, the gums will be chafed or ulcerated, the patient nauseated, and the piece rendered unstable by the action of the muscle. It is not always necessary to employ a very wide plate to give secure retention, for a comparatively narrow one will often adhere with very great tenacity to the gums. But such a plate is more liable to be bent and lose its perfect adaptation to the parts than a wide one, unless made thicker in proportion as it is narrower. As it is never necessary to make an upper plate so narrow as a lower one, there can be no difficulty in giving the requisite strength, either by increasing the thickness throughout or by doubling the anterior half.

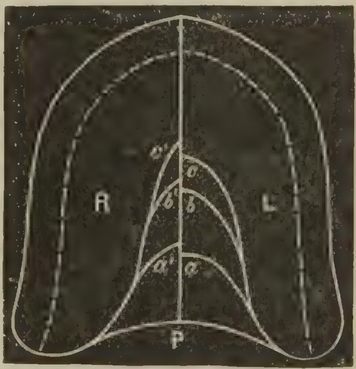


FIG. 1079.

The diagram (Fig. 1079) represents half-section outlines of six modifications of form in the posterior margin of the plate, where it is proposed to overcome the difficulties incident to a hard palatine membrane by cutting out the plate. The line P, curving forward from a

little behind the termination of the top of the ridge (dotted line), is the extreme limit of any plate not complicated with cleft palate. The curve *a* or *a'* will give surface sufficient for the retention of most plates, except in small arches. This form is more agreeable to the patient than the first, and is less apt to produce nausea; it removes the plate from all action of the palate muscles, and lessens the liability to dislodgment often caused by the forcible action of the tongue against the back of the palate in certain efforts of deglutition. The curve *b* or *b'* may often be used solely to avoid unnecessary covering of the palate. In mouths of average size and having moderate and regular softness such shape will prove quite as firm as one following the line P. But these lines are more frequently to be followed, for the same reason that we take the curve *c* or *c'* to keep the plate off the hard central ridge. When this ridge is narrow we give greatest width to the plate by following the curves on the side R of the diagram; but if the surface is broad the space must be widened, as on the side L, and the plate made thicker.

This method of relieving the central bearing of plates gives them great steadiness in the ridge, and has an advantage over other methods in having no band or ridge of plate pressing along the line P—a point very often as hard as any other part of the palate. It is advisable in those cases where a vacuum cavity has been tried with unsatisfactory results to cut out the cavity and part behind it, and thus try the effect of a plate following curve *b* or *c*.

There are other methods of taking off the central bearing of plates. When the ridge is soft a wax impression does this by compressing the gum. Models from plaster impressions are scraped on the ridge for the same purpose; but this is not so good a plan, as it is difficult to do it uniformly. A much better expedient is to brush some thin plaster over the central part of the model, being careful to mark the line of the back edge of the plate, and put no plaster there; this layer must not be thicker than a card, and should have no abrupt edges. A thin layer of wax may be added in the same manner to plaster models before molding in sand to obtain the die for swaged metal plates. In deep arches the shrinkage of the zinc die accomplishes the same object; if the model is carefully scraped along the back edge of the plate this part will fit closely, while the central portions will stand off; this is far better than the attempt to adjust the edge with pliers.

In adapting atmospheric-pressure plates the form and fit of the alveolar margin must be considered. Close adaptation of this edge is by no means so essential to firm retention of a full upper piece as in the posterior margin; for the reason that, in most cases, the loose mucous folds which lie against the plate prevent the access of air. But close-

ness of fit is very desirable for other reasons: to prevent lateral motion; to avoid unnecessary fullness; to prevent irritation of the soft parts by projecting edges of metal. The form of the alveolar edge is not essential to adhesion, provided it rises high enough to give steadiness to the plate. Esthetic considerations, however, often compel us to run the plates up as high as the muscular attachments will permit, either for the support of an artificial gum or to restore sunken features. In both jaws, especially the lower, the effort to get the deepest possible edge often gives instability by subjecting the piece to the action of the facial and lingual muscles. In any case of doubt make the plate too shallow rather than too deep; especially when the edge is turned over, which makes it impossible to take off any excess without spoiling the plate.

Full lower plates are held by adhesion of contact; but in these the weight of the piece increases the adhesion. The surface is so small that every part of such plates should fit the gum with accuracy. The simpler rule for the form of lower plates is to extend them as far on the inner and outer edges as the muscular attachments will permit. The outer and inner edges are often rounded by soldering a gold wire after determining the exact outline. Thickness of the edge is also given by doubling the plate necessary for the strength of narrow plates. The second plate is to be swaged precisely as the first; then, after partial trimming, the two plates are swaged together over a new die. One should be wider than the other on the outer or inner edge, to give a place for the solder; the borax cream should be free from granules, and the blowpipe flame directed on the edge opposite the solder. A simple and convenient clamp for binding plates together or holding rims while being soldered is made of iron (or nickel) wire (Fig. 1080). *a*, the first bend; *b*, the second bend; *c*, a side view of the same; *d*, side view of clamp, open and grasping two pieces of plate. The curves should be so adjusted that the points of contact with the plates will be just opposite, else clamp or plates are liable to change position.

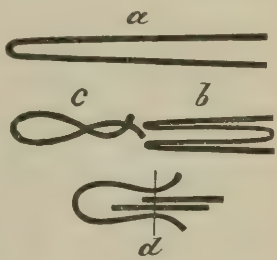


FIG. 1080.

Partial pieces may also be retained by closeness of adaptation; but there are two elements of instability which usually will prevent them from having the security of full sets or of partial clasp pieces—lateral movement and extent of margin, admitting air on slightest motion. All such pieces should, if possible, have two stays, one on each side of the mouth, to prevent lateral motion; they should cover an extent

of surface proportioned to the number of teeth; the edges of the plate should fit with great accuracy. If the exact outline of the plate is determined on, a good plan is to paint the model with a coat of thin plaster, keeping one-eighth inch inside the margin and laying an extra coating over very hard places; this causes the edge to sink slightly into the gum; yet if carefully done it will not change the general contour of the surface. Partial plates, holding the eight, ten, or twelve anterior teeth, if assisted by stays against the remaining molars, are nearly or quite as firm as full plates. But in either partial or full pieces, whenever the plate has to be cut off for setting the six front teeth directly on the gum, this dentated margin is more apt to admit air than the upturned rim, which has the folds of the lip lying against it. Partial lower plates are unstable, not from any admission of air, but because of the small extent of surface, inadequate to the pressure of mastication.

Plates for partial dentures to be held in place by clasps or bands are generally made narrow, and the posterior line or edge within the depression of the rugæ, so as to be out of the way of the tongue, but such plates must not be made too small, or they will cause pain by being forced into the mucous membrane. Partial lower plates for artificial bicuspids and molars, the six natural anterior teeth remaining in the mouth, should extend up on the lingual surfaces of the natural teeth to prevent the too great pressure of the plate against the inner surface of the alveolar ridge, and also to give greater strength by the increased width and form of the plate back of the natural teeth, which would otherwise have to be made very narrow and thick. The lower inner edge of full and partial lower plates should extend so far down as to be out of the way of the tongue. Carrying the edge of such a plate over the projecting surface of the ridge, which is generally present, into the receding underspace, will prevent the tip of the tongue from getting under it; at the same time the plate should not extend so far down as to interfere with the frenum of the tongue.

A tongue or catch may be swaged as part of a partial lower plate to extend slightly over the angle of the crown of a posterior natural tooth, such as a molar or bicuspid, and catch on the grinding surface, and thus prevent a partial lower denture from pressing painfully on the gum. This tongue or catch should be adapted to the grinding surface of the natural tooth at a point where it will not interfere to any great degree with the occlusion of the natural teeth. Partial stays fitting as far as possible into the interspaces between such natural front teeth as remain in the mouth, will prevent partial lower dentures containing artificial bicuspids and molars from sliding backward, as

all such dentures have a tendency to do. Such stays will also prevent the plate from being raised from its place by the cheeks and muscles.

THE VACUUM CAVITY.

In some mouths the base plate of a full upper piece adheres from the beginning with great firmness. When the gum is moderately and regularly soft, the palatine arch deep, and the mouth of average size, want of adherence, on trial of the plate, is positive evidence of defect in construction. But very hard or very small or very shallow mouths usually require time for the perfect adaptation of the best made plates. Dr. Dwinelle thus explains the temporary failure of a simple atmospheric pressure plate to fit firmly when first inserted. When the plate is applied and an effort made to exhaust the air the gums are drawn down so as to meet it along the line and behind the edge of the plate, thus resisting every effort made from without to withdraw the air from the central part of the plate; so that the pressure of the atmosphere is exerted upon only a small breadth of surface along its edge, where the adhesion is constantly liable to be disturbed in mastication.

With the view of obviating this difficulty the idea of constructing a plate with a cavity suggested itself to the author as early as 1835, and was mentioned at the time to several of his professional brethren. The construction of the chamber then devised was found objectionable and he abandoned its use; and it was not until the early part of 1848, when he had the opportunity of seeing a cavity plate upon a plan contrived by Dr. J. A. Cleaveland two or three years previously, that he was again induced to construct a base plate of this kind. Dr. Dwinelle made a cavity plate with an external opening and valve for exhausting the air in the winter of 1845; and in the summer of 1847 or 1848 Dr. Jahial Parmly exhibited to the author a plate with a simple cavity struck into it by swaging. Some months after he heard for the first time of a cavity plate patented by Mr. Gilbert, of New Haven. The cavity now generally employed is formed on the median line, either far back for full plates (Fig. 1081), or immediately behind the alveolar ridge for some partial plates. Dr. Flagg adds two lateral cavities on the slope of the palate with a view to prevent the plate from rocking and to give it increased stability. Dr. Levett's lateral cavities are placed directly upon the ridge (Fig. 1082). With this brief history of cavity plates we shall proceed to give a concise description of the manner of constructing them. The following is the mode of construction of Dr. Cleaveland's cavity plate, which, for reasons given below, is now seldom used.

A metallic die and counter-die having been obtained, a plate is

swaged, covering the entire alveolar border and extending back as far as the line P (Fig. 1080). This done, it is placed in the mouth, and if found to be accurately adapted to the parts it is removed; a half-round gold wire about the size of a common knitting needle is then soldered to the lingual side of the plate, enclosing a space shaped somewhat as is shown in Fig. 1081, varying in size and form with the differences in shape and size of the plate and alveolar ridge. The part within the wire is next cut out with punch-forceps or saw and the plate placed on the model; a piece of wax about a tenth or twelfth part of an inch in thickness, having a circumference one-fourth greater than the hole in the plate, is then placed over the opening, extending a short distance beyond the wire on every side. The wax at the outside is brought to a thin edge and is also made thinner in the center than where it covers the wire surrounding the opening in the plate. From this model with plate and wax upon it, die and counter-die are obtained with which to swage a thin plate of gold, large enough to cover the wax; its edge is chamfered off, and it is then

FIG. 1081.

FIG. 1082.

soldered to its place on the plate, where it may be secured during soldering either by iron wire clamps or by gold rivets. A sectional view of the cavity is represented in Fig. 1083 A. The Cleaveland cavity causes the plate to adhere with great tenacity, as from its shape it is impossible for the mucous membrane entirely to fill it; the traction of this cavity is constant. A serious objection to its use is the great irritation it excites in the mucous membrane in the majority of cases.

The simpler cavity plate used by Dr. Jahial Parmly, of New York, and patented by Mr. Gilbert, of New Haven, may be formed with nearly as much ease as a plain plate. Fig. 1083 B represents a sectional view of this description of plate. If it is desired to have lateral cavities, three pieces of wax or metallic forms are placed on the plaster model—one in the center, as already described, and one on the slope of the alveolar ridge on each side. When it is desirable to make a cavity with sharply defined border, D, a second plate a little larger

than the projection should be swaged over the base plate. From the base plate the projection is to be cut out and the smaller plate soldered over the opening. For hard mouths the thickness of the main plate will give sufficient depth of cavity, C ; in this case no projection is to be placed on the model.

Should the usual method of exhausting air from these cavities be thought insufficient, the valve of Dr. Dwinelle (Fig. 1083 V) may be inserted in the plate covering the cavity. The conical portion is neatly fitted by grinding ; the stem is soldered to a spring on the palatine surface. A valve of easier construction is given at V′; a small rubber pad acts, by the spring, upon the outside of the hole. The size of valves and thickness of plate are exaggerated, the better to illustrate the details of construction. By means of either of these valves a vacuum may be created, which will draw with great force upon the membrane over the cavity.

The forms B and D, Fig. 1083, necessitate a prominence in the

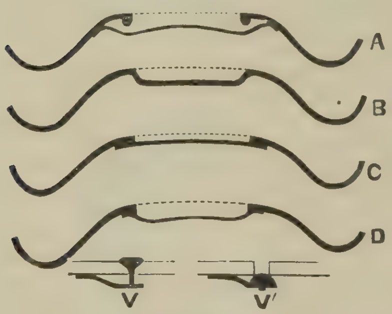


FIG. 1083.

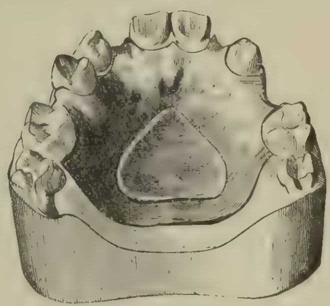


FIG. 1084.

die which is variously formed. When the die is made by sand molding, a corresponding one, formed of wax, lead, tin, or plaster, is put on the model ; a die made by dipping or pouring or by the fusible metal process requires plaster. Dies made by pouring into the impression require the cavity to be cut in the impression itself. A variety of shapes in tin and alloy are furnished by the depots, chiefly for vulcanite work ; but they may be used also for the sand molding model. Plates made by the metallo-plastic processes require plaster prominences.

The size, depth, form, and position of the cavity are important considerations. In size it must be proportioned to the plate. Fig. 1084 gives a fair average size and is excellent in form, except that it is unnecessarily pointed ; all angles and sharp corners should be avoided, and fanciful shapes are esthetic blunders ; the form should appear to

grow out of some necessity; and hence it should be modified to suit the form of plate. Shallow cavities may be larger than deep ones; partial pieces usually have a cavity larger in proportion.

Fig. 1085 represents the usual forms of vacuum cavities (the shield form being objectionable on account of its sharp angles), which may be metal, such as block tin, that will not discolor the rubber; vacuum cavities made of sheet lead are objectionable on that account.

In depth the cavity must vary with the softness of the membrane. If soft it quickly fills a shallow cavity and is less liable to injury by a deep one. Sharp-edged cavities fill less quickly than round-edged ones. They may vary in thickness from No. 14 to No. 24 gauge plate, page 826. When the cavity is designed, after a temporary retaining power, to act permanently in relieving the pressure on central hard parts, it should be very shallow. When, in very flat mouths, it is proposed to prevent lateral motion by the mucous prominence the cavity should be deeper. Extreme depth, with a view to keep up constant action, makes a most unsightly piece and injures the mouth.

When the center of the palate is very hard and unyielding, as is

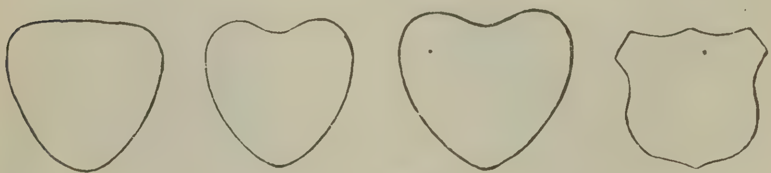


FIG. 1085.

generally the case, and not subject to change of form by pressure, while the alveolar ridge and some other parts are subject to absorption, if the palate is permitted to rest on the hard central portion, the result will be its rocking. This may be prevented and good adhesion secured by covering the entire hard palate on the plaster model from near the anterior margin to within one-fourth of an inch (or in some cases even less) of the posterior margin of the plate, when to be of metal, with a thin film of wax (about one-half the thickness of a wax base sheet), with the edge all round reduced even with the surface of the model. In vulcanite plates or sets adhesion can be secured on the same principle, by removing, with a large cone bur in the lathe, the same amount from the palatal surface of the plate.

As to position there would seem to be much difference of opinion, if we judge by the various points selected. We have never had but one opinion on this subject, and that is in favor of the central cavity. The cavity resists the greatest force of displacement when applied at right angles; as this force is always nearly or quite vertical, it follows

that the most effective cavities are horizontal ; hence they should only be on the roof of the palate and limited to its level portion. Cavities covering the rugæ or sloping walls of the palate act at disadvantage. Again, after the cavity ceases to act its secondary use in relieving pressure can be available only in this position. The very worst position for a cavity is on the ridge of either upper or lower jaw. Firm pressure on the ridge is one of the most important elements of stability in a plate. If is difficult to comprehend what compensation for the loss of this is found in the cavity.

Partial plates require, when the cavity is used, a modification of form to enable the cavity to be placed on the roof of the palate. Yet the shapes elsewhere given may be used in connection with Flagg's lateral cavities as represented by the oval in Fig. 1086. If no stays can be used, as in a piece of artificial bicuspids and molars with natural incisors and canines, a central or two lateral sharp edged cavities may be of service to prevent lateral motion. In all other partial cases stays may be used ; these, combined with accurate fitting, will give as

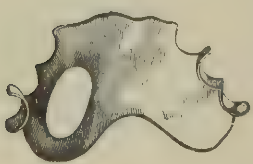


FIG. 1086.

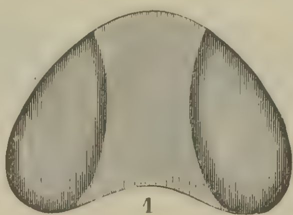


FIG. 1087.

firm a piece as any form of cavity. The vacuum cavity may also be formed in the impression by adapting a form of wax to the roof of the mouth in the proper position before inserting the tray.

Dr. C. H. Land has recently suggested a vacuum cavity pattern (Fig. 1087), which is claimed to be of such a form as to secure the greatest advantage from atmospheric pressure without injury to the mouth ; also to serve as a relief to the hard portions of the arch by being of sufficient depth to allow for continued absorption of the alveolar ridge in the case of first sets ; it is also claimed that its shape avoids interference with the organs of speech.

Dr. Joseph Spyer has devised an automatic suction cavity which, he claims, permits of the construction of a narrow plate with perfect adhesion.

Fig. 1088 is a view of Spyer's Suction Cavity as it comes ready for use. Fig. 1090 shows the Automatic Suction Cavity secured in position on the plaster model. Fig. 1089 gives a view of the palatal

surface of a finished plate, with metal form removed. While the Automatic Suction Cavity comes already shaped for the model, it is necessary to trim it down with curved scissors to meet the requirements of each particular case, always leaving a slight space between the slots or openings, A A, Fig. 1090, and the outer margin of the metal form. The Suction Cavity is then secured by means of pins, or by varnish or mucilage or any sticky substance, to the plaster model on the palatal surface inside of the alveolar ridge, leaving the alveolar ridge uncovered. A sharp instrument is then passed through the slots, A A, Fig. 1090, in the manner indicated in Fig. 1090, and carried their entire length, forming parallel grooves in the plaster model. Then the metal form is covered by the wax base plate, which should be the *size* of the finished plate, and in most cases approximating to the *form* of finished plate, shown in Fig. 1089. Upon the base plate the teeth are set up as usual, and the case flasked, packed, and vulcanized in the usual way. After vulcanizing, the metal form (the "Automatic Suction Cavity") *is removed.* If the parallel ridges are too high

FIG. 1088.

FIG. 1089.

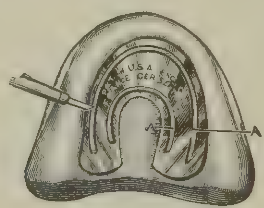


FIG. 1090.

after the plate is vulcanized, file them down to the desired height. The finished plate will have along the edge of its palatal surface two parallel ridges, as shown in Fig. 1089, besides the form of the suction, which provides strong adhesion from end to end of the plate.

Dr. Joseph Spyer has also devised for plastic work a thin metallic form, the surface of which is covered with minute papilliform prominences—shown in Fig. 1092 magnified four diameters—which by displacement of mucus at the points of gum contact effect surface cohesion as if the denture were glued to the gums, yet cause no irritation and leave no marked indentations. Adapted for either upper or lower plates. By the aid of this device it is claimed that strong cohesion can be had with a narrow plate, and thus the sense of taste be left unimpaired, and that lower plates so made are very firm. They are put up in packages containing one dozen forms size of Fig. 1091, which can be cut for either upper or lower plates. These forms are also made of gold with a thin covering of pure silver; the sulphur in

the rubber, when set free by the action of vulcanizing, sulphurizes the surface, and to this the rubber adheres.

Fig. 1093 represents Dr. Wünsche's metal adhesion form, which consists of a strong white metal plate, the material being hard enough to prevent the flattening of the convexities under any necessary pressure.

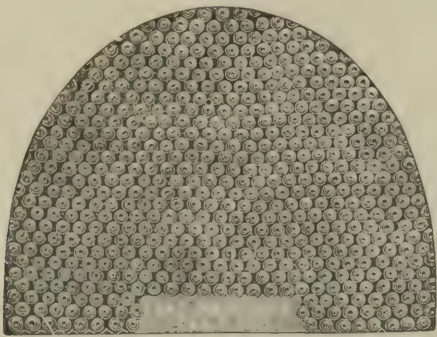


FIG. 1091.

SILVER PLATE AND SOLDER.—The processes heretofore described and the rules laid down have been considered mainly in their relation to artificial teeth mounted upon GOLD PLATE by the operation of soldering. But other metals may be swaged by the same processes, as platinum, aluminium, and silver.

Silver is the least valuable of these, and has nothing to recommend

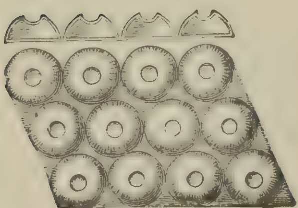


FIG. 1092.

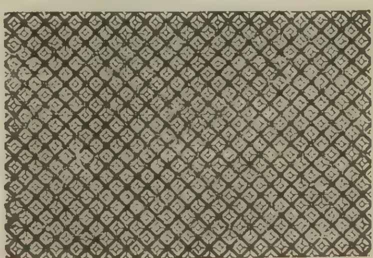


FIG. 1093.

it except its cheapness, in which questionable merit it has aluminium and vulcanite as its competitors, and hence it is now not very much used. It is manipulated in all respects like gold, except in the operations of refining by acids, the composition of solders used, and the care necessary in soldering, from the fusibility of the plate.

For plates pure silver alloyed with platinum possesses advantages

over coin silver, which oxidizes greatly in the mouth. The formula for such a plate is—

Pure silver,	1 ounce.
Platinum,	1 pennyweight.

Some prefer gold clasps for silver plates.

A good silver solder is composed of—

Pure silver,	6 parts.
Pure copper,	3 parts.
Pure zinc,	2 parts.

In the preparation of such a solder the silver and copper should be melted together and then the zinc added, pouring the molten mass into the ingot-mold before the zinc volatilizes.

Fine silver alloyed with one-third its weight of brass also gives a good silver solder, as the zinc in the brass reduces the fusing point of the alloy and makes it easy-flowing. If ½ to 1 grain of zinc is added to the above formula, the fusing point is still further reduced. After pouring the alloy into the form of an ingot, it should be rolled to No. 26 or 27, annealed, and its surface cleansed by placing it in the acid-bath.

Aluminium can be rolled into plate and swaged. It requires extreme care in annealing, but makes a rigid, strong, and very light plate. It does not withstand the buccal secretions as well as twenty-carat gold, nor is it as good as eighteen-carat gold. The obstacle to its general use also lies in the fact that as yet there is no good solder for it. Hence it is necessary to attach the teeth by vulcanite. This can be very successfully done, as vulcanized rubber adheres more closely to this metal than to any other, excepting, perhaps, pure gold or pure platinum. The process will be described in the section on Vulcanite; it is equally applicable to twenty-carat gold and to platinum, but not at all to silver. An alloy of aluminium which is cast directly upon the teeth is referred to under Metallo-plastic Work.

Platinum, if alloyed with five to ten per cent. of gold, has stiffness sufficient to be used as a base plate, in the manner previously given for gold. As it has no advantage over gold when used in this way its less cost is not a sufficient offset to the inconveniences attending its use and to the color, which is so objectionable to most persons that they are unwilling to pay as much as for the same work in gold. Platinum has, however, one remarkable property possessed by no other metal used by dentists except palladium, which is now scarcely at all, if ever, used; it cannot be fused in the highest heat of the forge or porcelain-baking furnace. Hence it is the only metal used for the metallic

pins and other fastenings inserted into porcelain teeth, requiring for its fusion the flame of the oxyhydrogen blowpipe. It is also the only metal used in a remarkably beautiful style of work known as the Continuous-Gum Work, which forms the subject of the next section.

CONTINUOUS-GUM WORK.

The idea of uniting porcelain teeth to a metallic base by means of a fusible silicious composition originated in France, where the method has to some extent been practiced since 1820. But Dr. Fitch, who spent much time in Paris and was well acquainted with the French method and Delabarre's formulæ, stated that the latter never perfected his recipes or brought them into practical use. The composition employed there, judging specimens, cannot be used in connection with porcelain teeth containing as large a proportion of feldspar as those manufactured in this country. Delabarre's compound, according to Dr. Locke, required 3761° Fahrenheit to fuse it completely. Below this it fused imperfectly and was found too fragile.

The process now known as the CONTINUOUS GUM consists essentially of a silicious paste, similar (except more fusible) in composition to that of which the teeth are made, which is applied around the bases and fastenings of teeth previously soldered upon a plate of purest platina, and then fused at a temperature of about 2200° Fahrenheit. It takes its name from the fact that, unlike blocks or single gum teeth, it presents an unbroken continuous gum outside the alveolar ridge, as is shown in Fig. 1094. It is applied in two layers—a yellowish-white *body*, giving the general contour of the gum, and an *enamel*, to produce that correct imitation of the natural gum for which nothing but ceramic materials have as yet been found suitable. Dr. Allen covered with the same material the entire lingual surface of the plate, and also certain projections outside of the molars and above the cuspids, designed by him for the restoration of the natural fullness of the face.

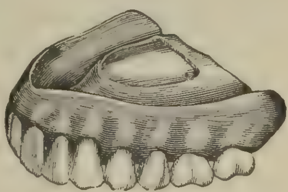


FIG. 1094.

This falling in of the features is due to the absorption of the alveolar ridge, and cannot be fully restored by an artificial set of teeth as usually made; since if the molars were set out to the original width of the teeth the force of mastication would fall outside the absorbed alveolus and render it practically useless. Dr. Allen's device corrects this sinking under the malar prominence of the superior maxilla and in the canine fossa, and thus greatly aids in the restoration of the face to its original appearance.

This process was patented by Dr. John Allen in 1851; but the priority of invention was contested by Dr. William H. Hunter in a suit, the progress and result of which were published in the dental periodicals of that period. Dr. Allen surrendered his patents of 1851, owing to certain defects in the same, and in 1856 a new patent was issued to him for the process as then improved. The process is very generally known as "Allen's Continuous Gum." The formulæ given in this chapter are those of Dr. Hunter, and the earlier ones of Dr. Allen. As all such materials are more perfectly prepared on a large scale, we think it much better to purchase than to make them.

A "continuous gum" piece made in the most perfect manner is only surpassed in point of beauty by the occasional productions of a very few block carvers; but so rare are these specimens of perfection in block work that we may safely say of the continuous-gum work that when properly made it is the most beautiful, as it certainly is the purest and sweetest, that can be worn in the mouth, so long as the porcelain covering maintains its integrity. It was thought when this method of mounting artificial teeth was first adopted that the springing of the plate in the act of mastication would cause the gum to crack and scale off, which did occur in a large proportion of the cases. Although the injury could be repaired by replacing the loss with fresh composition and fusing it to the fractured edges of the remaining portions and to the plate, yet this at one time formed a very serious objection to its use. But later improvements in the strength of the compound and also in the rigidity of the plate and soldered backings, or long pins, have so far corrected this evil that it is perhaps no more liable to accident while in the mouth than any other kind of work. But out of the mouth its weight renders it peculiarly exposed to accident; a fall is almost certain to break one or more teeth or crack the silicious covering of the plate. Hence it is necessary to impress upon the patient the great importance of the most careful handling.

By uniting the teeth to each other near their base and to the plate with a glazed porcelanic material, the cleanliness of the substitute is most perfectly secured; as all the openings beneath and around them are completely closed, excluding the secretions of the mouth and particles of food, which have no affinity for or action upon the porcelain. In this respect they are superior to the most perfectly mounted block-teeth, while the labor of putting up a set of the former can be performed in half the time required for making and mounting a set of the latter. A person who can mount single teeth well may acquire a knowledge of this method with proper instruction in a few weeks; although much of the peculiar talent required in block-carving is needed in arranging the teeth and shaping the gum for this process,

the details are comparatively simple and may soon be taught. Of course, much practice will be required, especially in the management of the furnace heats. The necessity for such practice, to enable one successfully to manage the furnace, is the chief obstacle to its casual use by the practitioner. Unless he makes it a specialty, and does all his own work and some for his neighbors, he will be certain to meet with many discouraging failures in the final process of baking an otherwise perfectly constructed piece.

We therefore advise the dentist to swage the platina plate, select and arrange and articulate the teeth; for no one should be so competent to do this as the one whose intercourse with the patient enables him to judge exactly what form, color, and arrangement of teeth are best suited to the case; and only he can decide upon the correctness of the fit of the plate. But when all this is done the piece should be securely packed and sent by express or mail to some experienced worker in the continuous-gum. The piece will be returned with the plate unchanged in shape, and the porcelain work executed in such style as can be reached only by constant practice and familiarity with the special details of this work.

The artificial gum consists, as we have stated, of two parts; the first is termed the *base* or *body*, as this constitutes the principal part of the cement, and is used for filling in between the teeth and building up the gum on the plate; the other is *gum enamel.* The materials employed by Dr. Hunter in the composition of his compounds are silex, fused spar, calcined borax, caustic potash, and asbestos. The silex and spar should be of the clearest and best quality, and ground very fine. The asbestos should be freed from talc and other foreign substances and reduced to a fine powder. He gives the following formulæ and directions:—

FLUX.—Take of silex, 8 oz.; calcined borax, 4 oz.; caustic potash, 1 oz. The potash is first ground fine in a wedgewood mortar, and the other materials gradually added until they are thoroughly mixed. Line a Hessian crucible (as white as can be had) with pure kaolin, fill with the mass, and lute on a cover of a piece of fire-clay slab with the same. Expose to a clear, strong fire in a furnace with coke fuel for about half an hour, or until it is fused into a transparent glass, which should be clear and free from stain of any kind. This is broken and ground until it will pass a bolting sieve.

GRANULATED BODY.—Spar, 3 oz.; silex, $1\frac{1}{2}$ oz.; kaolin, $\frac{1}{2}$ oz.; completely fused. Break and grind so that it will pass through a wire sieve No. 50, and again shift off the fine particles, which pass through No. 10 bolting cloth, which leaves it in grains about the size of the finest gunpowder. It may be made of hard porcelain, fine china, or Wedgwood ware.

Body.—Take flux, 1 oz.; asbestos, 1 oz.; grinding together very finely, completely intermixing. Add granulated body, 1½ oz.; and mix with a spatula, to prevent grinding the granules of body any finer.

Enamels.—No. 1. Flux, 1 oz.; fused spar, 1 oz.; English rose red, 40 grains. Grind English rose red extremely fine in a mortar, and gradually add the flux and then the fused spar, grinding until the ingredients are thoroughly incorporated. Cut down a large Hessian crucible, so that it will slide into the muffle of a furnace, line with a mixture of equal parts silex and kaolin, put in the material, and raise the heat to the point of *vitrification*, not *fusion*, then withdraw from the muffle. The result will be a red cake of enamel which will easily leave the crucible, which, after removing any adhering kaolin, is to be broken down and ground tolerably fine. It may now be tested, and if of too strong a color tempered by the addition of *covering*. This is the gum which flows at the lowest heat, and is never used before soldering.

No. 2. Flux, 1 oz.; fused spar, 2 oz.; English rose red, 60 grains. Treat the same as No. 1. This is a gum intermediate and is used upon platina plates.

No. 3. Flux, 1 oz.; fused spar, 3 oz.; English rose red, 80 grains. Treat as the above. This gum is used in making pieces intended to be soldered on, either in full arches or in the sections known as *block work*. It is not necessary to grind very fine in preparing the above formulæ.

Covering.—What is termed covering is made by the same formulæ as for the enamel, omitting the English rose red. Being without any coloring whatever, it is used for tempering the above enamels when too highly colored, which may be done by adding, according to circumstances, from one to six parts of covering to two of enamel, thus procuring the desired shade. When it is to be used for covering the base prior to applying the enamel it may be covered with titanium, using from two to five grains to the ounce.

Investment.—Take two measures of white quartz sand, mix with one measure of plaster-of-Paris, using just enough water to make the mass plastic, and apply quickly. The slab on which the piece is set should be saturated with water to keep the material from setting too soon, and that it may unite with it.

Memoranda.—In preparing material always grind dry and use the most scrupulous cleanliness in all the manipulations. In all cases where heat is applied, it should be raised gradually from the bottom of the muffle, and never run into a heat. Where it is desired to lengthen any of the teeth, or to mend a broken tooth, it may be done with *covering*, properly covered with platina, cobalt, or titanium.

In repairing a piece of work wash it with great care, using a stiff brush and pulverized pumice stone. Bake over a slow fire to expel all moisture and wash again, when it will be ready for any new application of the enamel. Absorption occurring after a case has been some time worn, by allowing the jaws to close nearer causes the lower jaw to come forward and drive the upper set out of the mouth. By putting the *covering* on the grinding surfaces of the back teeth in sufficient quantity to make up the desired length, this difficulty may be to some extent remedied.

Any alloy containing copper or silver should not be used for solder or plate, if it is intended to fuse a gum over the lingual side of the teeth, as it will surely stain the gum. Simple platinum backs alone do not possess the requisite stiffness, and should always be covered—on platinum with the enamel, and on gold with another gold back. In backing the teeth lap the backs or neatly join them up as far as the lower pin in the tooth, and higher if admissible, and in soldering be sure to have the joint so made *perfectly soldered.*

The compositions originally employed by Dr. Allen consist of—BODY: Silex, 2 oz.; flint glass, 1 oz.; borax, 1 oz.; wedgewood ware, 1½ oz.; asbestos, 2 drams; feldspar, 2 drams; kaolin, 1 dram. ENAMEL: Feldspar, ½ oz.; white glass, 1 oz.; oxid of gold, 1½ grains. Since the publication of the early editions of this work great improvements have been made in the composition and preparation of both the body and gum enamel, which are furnished by the manufacturers, and may be obtained at any of the dental depots at a very moderate price.

The metals which may be employed for the base in this method of mounting artificial teeth are platinum or pure palladium. The common commercial article of palladium is not pure, and is never used in this country. Platinum, alloyed with from 1 to 10 per cent. of pure gold, may also be used; but it is objectionable from its liability to spring or warp. It makes a stiffer plate, and so far has the advantage over pure platinum, but for the reason given the purest metal should be selected. Because of its softness it must be used thicker than gold plate. The process of swaging the plate is the same as before given. It must be often annealed and gradually carried into any deep depressions, for its softness makes it more liable than gold to be torn, made thin, or punched through. A narrow rim, partially turned up, is to be left around the outside. The process of articulating, etc., is similar to that for gold. In adjusting the teeth accurate grinding is unnecessary; but each tooth should *touch* the plate. Part of each backing, where the teeth are lined, should lap over the adjoining ones, and behind the six front teeth should also be lapped over an additional narrow band,

to give greater rigidity to the plate. Continuous gum teeth with long pins are now used, the ends of the pins being bent down to the plate, to which they are soldered with pure gold; hence backing the teeth is not necessary. In this process there is great opportunity to give to the teeth that irregularity of arrangement which forms one of the characteristics of natural teeth, neglect of which gives to many otherwise excellent pieces of work an unnatural, artificial appearance, that shows great deficiency in the cultivation of dental *esthetics*.

Before applying the *body* the piece may be tried in the mouth and any inaccuracy of articulation readily corrected; careful articulation makes this trial unnecessary; but if from any causes changes are found on trial to be needed, they can be made more readily in this work before the gum is added than in any other; since no joints or neat fitting to the plate are disturbed by changes in the position of a tooth. After this the piece should be set in a mixture of plaster and asbestos or plaster and sand, resting on a muffle slide and coming up around the outside of the teeth to keep them in place. The solder used must contain no trace of either silver or copper, as such metals will stain the gum enamel and body, but must be either pure gold or alloyed with about 5 per cent. platina. Borax may be used, not in this case as a flux—for where there is no oxidation no flux is required—but to hold the pieces of solder in place until ready to flow. The slide is then gradually carried in to the muffle, and the whole piece raised to the melting point of the solder.

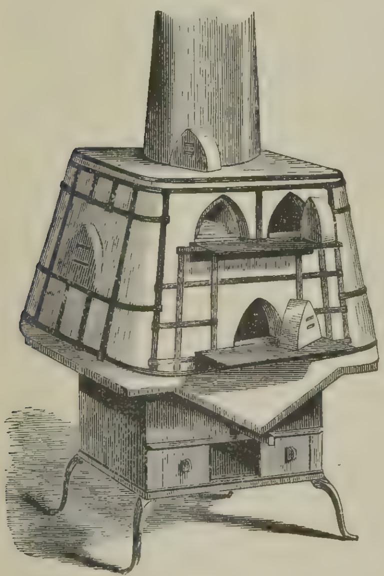


Fig. 1095.

Figs. 1095, 1096, and 1097 represent three of the most approved forms of furnaces.

The Combination Gas and Gasoline Furnace of Dr. Land is represented by Fig. 1096, in which is shown this furnace thrown open, being swung on hinges at the back, exposing the muffle E. The groove P P is packed with asbestos fibre, so that when the sections are brought together the furnace will be perfectly air and gas tight. It is claimed that with gasoline gas porcelain teeth can be enameled

in from ten to fifteen minutes, with ordinary illuminating gas in from fifteen to twenty minutes, according to quality.

Fig. 1097 represents Downie's Continuous Gum Furnace, in which it is claimed that a full case can be baked in from fifteen to twenty-five minutes.

The tempering ovens are on each side of the opening into the muffle,

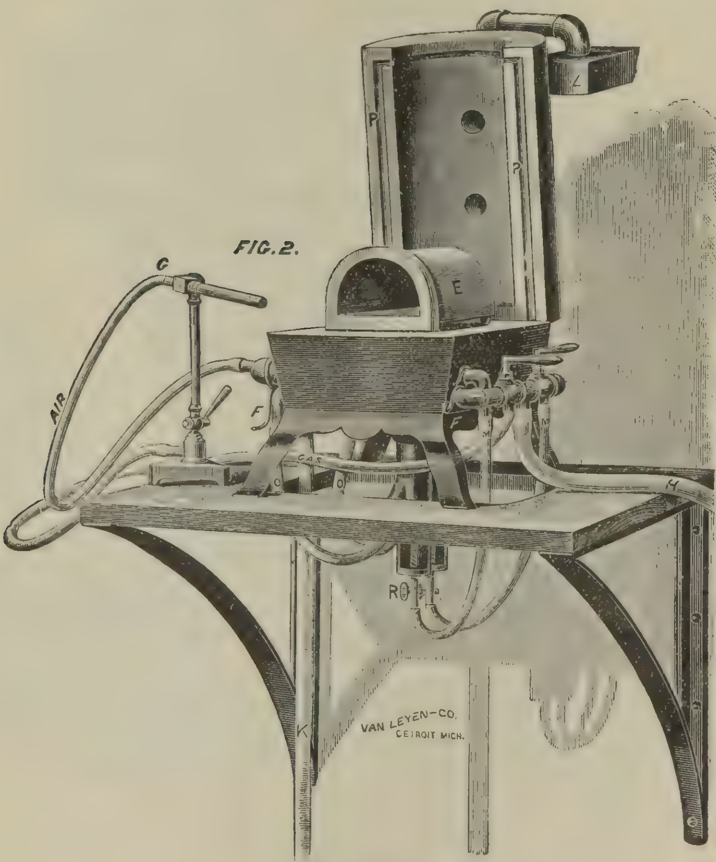


FIG. 1096.

and the hearth is provided with two sides, so the case can be brought out on to the hearth and put into the tempering oven by simply shoving the slide to one side by the small porcelain knob seen at the bottom of the hearth.

The rules for the management of the heat are the same as hereafter given for block work. The heat required for this is not, however, so

great as that required in block work; the gold and the continuous-gum materials fusing at about 2200° Fahrenheit.

Having thus soldered and cooled off the piece very gradually, it

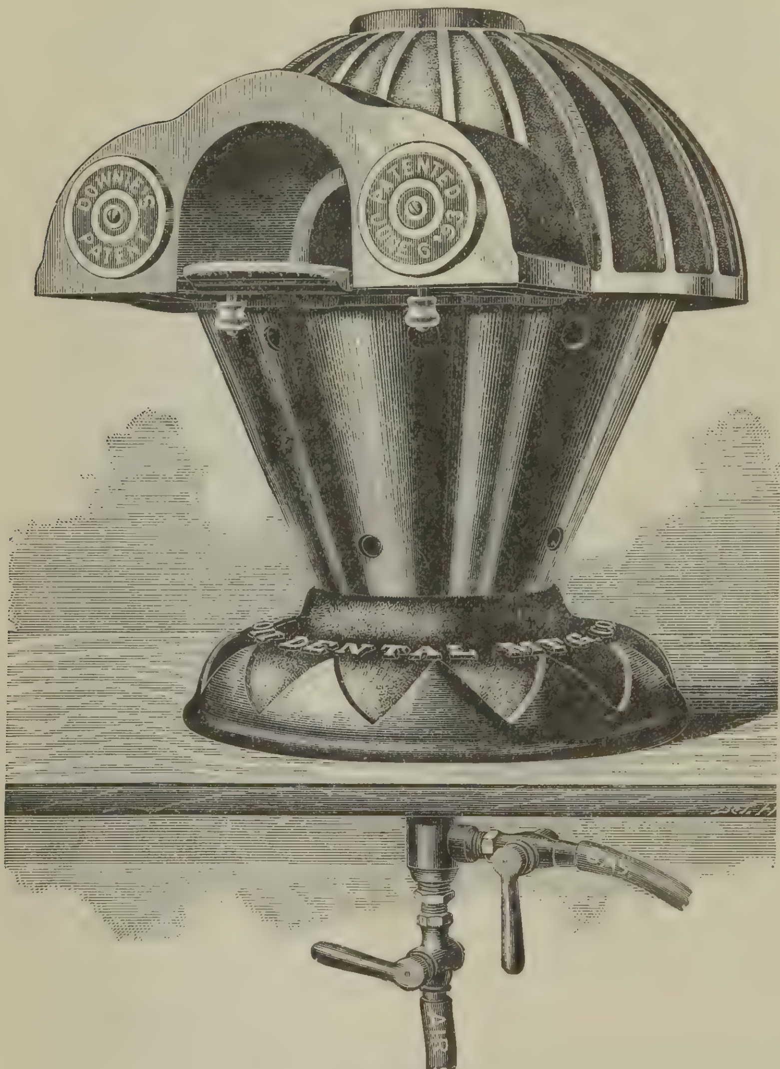


FIG. 1097.

must be thoroughly washed, so as to remove every particle of investment. Then, with a camel's-hair brush and small knife, such as are used in block carving, the spaces between the teeth and plate are to

be perfectly filled with a finely compacted paste of *body* and rain water. The paste must be applied very moist, so as to exclude the air and run into all the spaces; then dried with cloth or bibulous paper and compressed with the knife. If the lingual surface of the plate is to be covered, this should be made rough by either etching the surface or by soldering small clippings of platina over it at the time the teeth are soldered. The natural rugæ of the palate should be imitated in the thin layer of body which is applied.

The work must then be slowly and thoroughly dried and the piece put on a slide with the coronal ends of the teeth downward, and imbedded to the depth of an eighth of an inch in a thick batter of plaster and asbestos. But if the teeth are very securely soldered it will be best to flow the body with the plate resting, teeth upward, on the plaster and asbestos or sand model on which the soldering was done. The slide is then gradually introduced into the muffle and subjected to a heat sufficiently high to fuse the compound—say twenty-two hundred and fifty degrees. It is then withdrawn slowly and completely cooled. Usually there will be cracks and flaws which need filling with paste. The outside rim is also to be turned down over the edge of the body with hammer and pliers, and any defects at this point filled up; then heat a second time with the same care as at first.

The piece, now ready for enameling, should present a semi-vitrified appearance; if too highly glazed it is too much done, and the enamel will not take so firm a hold; if too dull looking it is not sufficiently baked, and will be deficient in strength. The enamel must be applied moist, and is best put on with a brush; much plastering with a knife makes it apt to fly off in baking, and for the same reason it must be heated *very* gradually. The layer of enamel should be thin and irregular, the yellowish white of the body showing more or less through it, so as to give the variations of tint observed in the natural gum. If a thick and even layer is applied the result will be an unnatural uniform color, which will destroy much of the peculiar beauty of this work.

The greatest care is necessary in applying the paste to remove every particle from the parts of the teeth and plate which are not to be covered, as it adheres with great tenacity and roughness, and disfigures these parts. Much experience is also necessary in determining the exact heat necessary to develop the full beauty and strength of the work. Repeated heatings, either for the first making or for repairs, do not injure the plate or teeth, provided proper care is taken to heat and cool gradually; and provided, in case of repair, the piece is thoroughly cleansed in strong soda to remove all trace of the buccal secretions.

The work is peculiarly adapted to full lower dentures. The principles of construction are precisely the same, only the plate should be very heavy, and the extra band behind the six or eight front teeth very thick and strong. Many use it for partial cases ; for which, however, it is not as well suited as for entire dentures. The three distinguishing advantages of the continuous-gum work are its ready adaptability to every variety in shape of gum and arrangement of teeth, its extreme beauty, and its great cleanliness ; its three disadvantages are its weight, its liability to be broken by accident, and its comparative inapplicability to partial cases.

CHAPTER XIV.

MOLDED PLATES OF PLASTIC MATERIALS.

In the classification of operations for the Replacement of Teeth given on pages 655 and 656, difference in the order of these operations was made the groundwork of a division of all BASE PLATES into two classes : SWAGED and PLASTIC. In describing, up to the point of completion of the model, the operations common to both classes, the modifying requirements of each were duly considered. The special order and details of swaged work were then taken up, with incidental allusions to plastic work, by way of comparison or contrast. Operations, materials, and apparatus peculiar to the latter will form the subjects of this and succeeding chapters.

PLASTIC WORK includes all dental substitutes in which the base plate is brought into contact with the teeth and the model of parts to be fitted whilst in a fluid, softened, or plastic condition, then hardened, during continuance of this contact, either by the application or the withdrawal of heat. Plasticity, as thus used, is the property of being molded, and has already been spoken of as an essential quality of impression materials. In them it is associated with other qualities especially fitting them for this particular use ; so in plastic work mere plasticity is of no avail, if other properties do not give to the material the qualities essential to a base plate. It must have strength and durability, and must be in harmony with the parts to which it is applied. This harmony implies that it shall not act injuriously upon the mouth or receive injury from it ; that it shall not, in form, color, taste, or smell, be repulsive to patients. It ought not, if possible, to be even objectionable ; but tastes are so variable that this contingency

cannot be a positive ground for exclusion of an otherwise valuable material.

As in swaged work there are four metals of which plates may be formed—gold, platinum, aluminium, and silver—in plastic work there are five varieties of plastic material of which plates may be molded: 1, Porcelain clay; 2, tin and its alloys; 3, sulphurated gum; 4, celluloid and modifications; 5, aluminium and its alloys; 6, electro-metallic. The first two have been longest in use; the third and fourth have become the most important in modern dentistry; the fifth and latest has yet to pass the ordeal of experience. The *first* is molded by tools, not in flasks, as are the other four; it also requires intense heat to vitrify or harden it. The *second* is made plastic by fusion, requiring a flask, hot, to prevent cracking of teeth, and tight, to prevent escape of metal; these plates harden by cold. The *third* and *fourth*, less plastic, demand force in the act of molding; they are hardened by heat; but the temperature to which the teeth are subjected is less than in the other three. The *fifth* is made plastic by fusion; but, though more plastic than the third, in its pure state it does not flow as readily as the second; its extreme lightness and sluggish flow necessitate peculiar apparatus in molding; but some of these disadvantages have been overcome by alloying it with other metals. The *sixth* is a process by which gold and silver are deposited upon the surface of the plaster model prepared for the purpose.

Comparing them in respect of certain other properties—weight, durability, strength, and necessary thickness of plate; amount of change in shape, from contraction; resistance to change by the action of the buccal fluids—vulcanite and celluloid are lightest; aluminium being thinner, is very nearly as light; porcelain, though a light substance, requires such bulk that it is heavier than either; tin and its alloys are heaviest. Vulcanite plates, properly made, are strong, durable, and may be as thin as any, except aluminium; aluminium plates are thinnest and strongest; the durability of pure aluminium plates is still an open question; tin alloys are variable, some being tough and strong, others stiff and brittle, others soft and flexible; they have about the same bulk as gum, and the best are perhaps nearly or quite as durable. Porcelain plates contract very much; aluminium much less, but still very considerably; tin alloys contract very slightly; gum has no contraction. Porcelain most perfectly resists the buccal secretions and substances taken into the mouth; vulcanite nearly or quite as effectually; tin alloys undergo some change; aluminium is not changed by sulphur, as silver is, but will probably be found, in some mouths, to undergo slight change.

To give uniformity to nomenclature, the four varieties of plastic

work will be classed under four heads. 1. Ceramo-plastic, or porcelain. 2. Metallo-plastic, including tin, cheoplastic metal, other tin alloys, aluminium, and gold alloy. 3. Vulcano-plastic, including caoutchouc, gutta-percha, and all vegetable substances that by combination with sulphur, iodin, etc., have the property of hardening by heat under the process known as "vulcanizing." 4. Celluloid and its modification, zylonite, which are molded by heat.

CERAMO-PLASTIC WORK.

Porcelain plates are remarkable for cleanliness, and in the hands of a skillful worker in the ceramic art may have great artistic beauty. There are, however, several considerations that must prevent their extensive use. Like continuous-gum work, ceramic plates are best adapted to full sets. They are frail, occasionally breaking under the force of powerful mastication; they will inevitably break, falling on any very hard surface. It is but just, however, to state that the few who make porcelain plates a specialty claim that they are no more liable to accident than other pieces; that the teeth of all, especially continuous-gum, are as apt to break as this work; and that a broken tooth or plate is more easily and quickly mended in porcelain-plate work than in any other.

A second objection is the great shrinkage of any strong porcelain substance. Efforts to correct in the material itself this shrinkage make it proportionately weak. Correction by enlargement of the model is not only troublesome, but it is uncertain; the same is true of the correction by grinding with corundum wheels, which is very tedious and cannot be exact. When base plates were made of ivory and fitted to the mouth by carving, this imperfection of porcelain plates was not objected to because the former fitted no better, if as well; but in contrast with the exact adaptation of other forms of plastic work and of swaged plates it becomes very manifest. There are many mouths in which a porcelain plate could not be retained at all; there are others which adapt themselves so readily to moderate inaccuracies that such a plate is worn with entire satisfaction.

A third objection is the necessity of constant practice to keep up that skill in ceramic art which is essential to an artistic piece, and to insure uniformity of result by proper control of the furnace. This difficulty, however, can be met in the same way as in continuous-gum work. If the dentist will make the model, select and articulate the teeth, arrange them on a temporary plate with wax to give the fullness of gum, and a sample tooth to show its color, then pack securely and send to any block carver or porcelain teeth manufacturer, he can have a porcelain plate made better and with more certainty than only an

occasional practice will enable him to do for himself. If it is desired that the teeth and plate shall be carved at the same time, it will be sufficient to send correct model and articulation, with directions as to the style, color, etc., of the teeth. We think, however, that it will be safer for the dentist to select and arrange the teeth, as he can better judge what is appropriate than one who does not see the patient.

For details of construction the reader is referred to other chapters. Impression and model are made like any other work; articulating processes are the same as for other forms of plastic work; grinding the teeth is very simple, as in continuous-gum work; enlargement of the "furnace model" and manipulation of the porcelain mixture will be described in the chapter on Porcelain.

CHAPTER XV.

METALLO-PLASTIC WORK.

THE use of a fusible metal in the construction of base plates is by no means new; but many of the metallic compounds suggested or now used for this purpose are of quite recent introduction. Except aluminium, none of them fuse above the melting point of tin, 442°. Pure tin is the oldest form of metallo-plastic base plate, and was used exclusively for the lower jaw. It is objectionable on account of its softness; even in a heavy lower rim it is apt to bend, and for an upper plate it is wholly unsuited. In its resistance to chemical change in the mouth it stands next to gold and platinum; is superior to silver and probably to pure aluminium; superior also, in this respect, to any of its own alloys. The process of constructing a lower plate of pure tin is the same as for any of the tin alloys.

Tin may be made harder and more rigid by alloying with Gold, Silver, Copper, Antimony, Zinc, Lead, Bismuth, or Cadmium. Copper and lead make it unfit for the mouth; antimony, zinc, and bismuth make it brittle, unless used in very moderate proportion. Silver gives it hardness, also cadmium, without imparting the objectionable properties named. Probably the best of all alloys for tin is cadmium. Closely resembling tin in its physical properties, it hardens it without making it too brittle or imparting increased liability to the action of fluids of the mouth. The majority of tin alloys at present recommended for base plates contain cadmium, with some zinc, antimony, or bismuth; they ought not to contain copper or lead.

Cheoplastic, Wood's, Weston's, and Watt's Metals.—The Cheoplastic Metal was patented by Dr. A. A. Blandy in 1856, together with certain processes used in the construction of dental plates. The manipulations since so familiar in the working of vulcanite were then as unknown as vulcanite itself. The peculiar merits of plastic work were at once recognized by many of the profession, and the Cheoplastic process would have passed into very general use, with such modifications as experience may have dictated, had it not been for the introduction of Hard Rubber. After some years' contest the profession decided in favor of rubber. Dr. Blandy's departure from the States in 1862 and the failure of the supply of his metal led to a total disuse of the cheoplastic metal.

The abuses of vulcanite and the gross mismanagement of rubber patents during their continuance urged many advocates of plastic work to revert to various tin alloys which are, in their principle of composition and in the essential character of the processés employed, identical with Dr. Blandy's patents. The name chosen by him (signifying the making of plates by *pouring* a metal made *plastic* by heat) is equally applicable to all alloys of tin now used. The alloy of the cheoplastic metal was silver with some bismuth and a trace of antimony. The exact proportions are not known, but may be learned by reference to the patents. The alloy imparted no taste whatever to the mouth; and its purity, so far as its capability of resisting the action of the secretions of the buccal cavity is concerned, was said to be equal to eighteen-carat gold. Its color became slightly darker after being worn some weeks, but could be restored by placing it in a strong solution of caustic potash.

The cheoplastic metal was the pioneer of the numerous alloys of tin (stannum) which are now claiming the attention of the profession. We have elsewhere spoken of the necessity of testing all such alloys in the crucible of "practice." We shall mention those of Drs. B. Wood, H. Weston, and George Watt,—the first because next to the cheoplastic metal it has been longest known to the profession, particularly those alloys adapted to the filling of teeth; the last because they are very strong, flow well, and retain their color well. The formula of Watt's metal is given as "tin, 40 dwt.; silver, 8 dwt.; bismuth, 16 grains."

Of the composition of Dr. Weston's alloy we know nothing beyond an assurance that it contains no copper, antimony, zinc, or lead. It may be better than any of its competitors closely resembling it; but, in ignorance of the formulæ of any of them, we can only say what, perhaps, if we knew these formulæ we might still say—submit to the test of experience that which seems to be the best. Dr. Wood's alloys

are the result of an elaborate series of very careful experiments made some ten years ago. His plate alloys consist mainly, perhaps altogether, of tin and cadmium; they vary in fusibility, hardness, and rigidity, but are nearly, if not all, more fusible than Weston's metal. Dr. Watt's metal is said to withstand the chemical action within the mouth as well, if not better, than 18-carat gold, and to be strong and to run sharp. Molds may be made in almost any flask, but a special flask known as Watt's molding flask (Fig. 1098) is better adapted to the use of this metal than the ordinary flask. The following instructions, in connection with what remain to be given for vulcanite, will be a sufficient guide in the construction of plates made of Wood's, Weston's, Watt's, or any other stannic alloy.

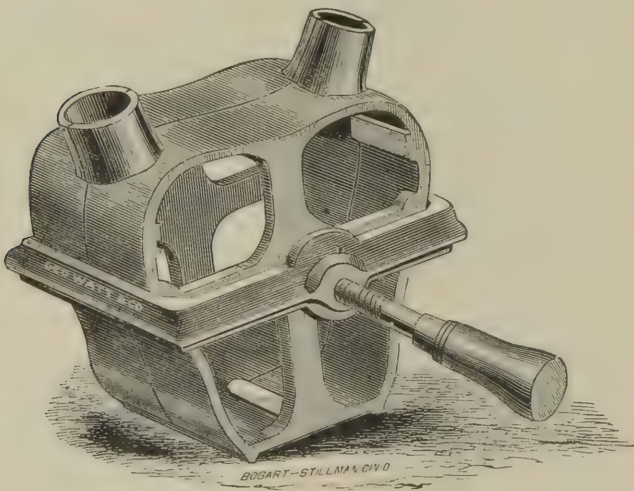


FIG. 1098.

Teeth for rubber work are best suited for this with the following precautions: First: Grind off the thin upper edge of gum teeth or sections; the anterior band is useful in rubber and does no harm; if of metal it is apt to crack the block and is unnecessary, as teeth are rather more firmly set in metal than in rubber; hence no metal should overlap the upper edge of the gum. Secondly: In jointing blocks do it as squarely as possible; if merely the edges of gums touch, the slight contraction of the alloy may cause them to scale or break. If, however, from accident or necessity this last kind of joint occurs, do as in soldering blocks to gold plate—place a thin piece of paper in the joint before securing it to the wax plate. Before drying the flasks this slight space caused by the paper may be closed with plaster and soluble

glass, to prevent metal from running in and making a metallic seam on the front of the block. Thirdly: Be careful to cover the pins with the wax which gives shape to the metal, so that in finishing up the latter they will not be exposed.

The Weston's improved flask consists of two rims without top or bottom, to permit rapid escape of moisture. It is much larger than the ordinary flasks, so as to allow room for the gate and reservöir posterior to the plate. It closes with two small bolts with nuts, and stands on feet. It is very important to screw the flask up well before pouring, that the weight of fluid metal may not separate the halves of the flask; the slightest space will allow much or all the metal to flow out.

The plaster may be mixed with soapstone powder, pumice powder, or clean white sand. Asbestos would prevent shrinkage, but its fibres would interfere with the free flowing of the batter. The same care in heating the flask is necessary as before stated, remembering that plaster confined in metal flasks takes longer to become dry. It is not safe to pour under less than three hours' drying; and this must never be done in direct contact with flame. Moisture is one of the products of combustion in all flame, and is largely absorbed by the plaster; hence plaster over flame can never be made perfectly dry, unless contained in some box, say of sheet iron, excluding this vapor.

Directions for heating, pouring, cooling off, and finishing are as follows:—

All necessary trimming of the plaster is done before the wax is removed, to prevent small pieces from falling in the matrix by the sides of the teeth. All of the wax is now removed, as the absorption of any considerable portions left in the matrix has a tendency to roughen the surface, and thus to prevent the metal from running as smoothly as it would otherwise do. After removing the wax each half of the matrix may be held over the flame of a tallow candle until a slight coating of lampblack forms on it. The two parts are now screwed firmly together.

The flask may now be placed in a kitchen range or bake oven and exposed to a bread-baking heat, say from 300° to 400° Fahr., for from three to five hours, or until every particle of moisture is driven from it; then placed in an upright position and the melted metal poured quickly into the matrix. If there is no ebullition and the metal comes up into the vents freely, the piece will come from the matrix in a perfect condition. If it bubbles it may be lightly tapped several times on some hard surface. When perfectly cold the two parts of the matrix are separated, exposing one of the surfaces of the plate.

Dr. A. Allen describes the method of using Watt's metal as follows:—

"The method of constructing a case is the same as for any of the

fusible alloys, or as follows: After securing the impression in the usual manner, give it a thin coat of shellac, then a thin coat of sandarac varnish; after the varnish is dry, soak in water and pour model without oiling impression, using a mixture of two parts plaster and one part Spanish whiting, or a mixture of two parts of plaster and one of finely ground asbestos.

FIG. 1099.

"The plate may be cast directly on to the teeth, or the base plate may be cast and the teeth attached in the usual manner of making rubber attachments.

"Teeth intended for rubber are most suitable for this work. If gum sections are used, grind square joints and slip a strip of writing paper into each joint while waxing up, removing just before flasking.

"If simply a base plate is to be cast, a piece of ordinary base plate wax is carefully molded over the model and trimmed to the gum line and dovetailed lugs added to secure the rubber (Fig. 1099). A rim with an under-cut edge may also be added if desired (Figs. 1100 and 1101). If for upper case the base plate should be of much thinner wax (Fig. 1100).

FIG. 1100.

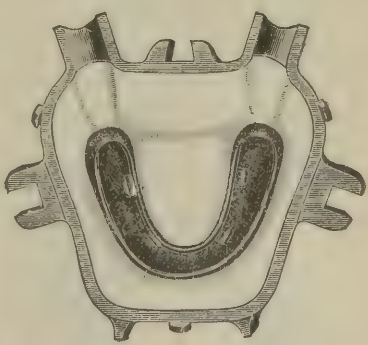


FIG. 1101.

"If the case is to be cast directly on to the teeth, set them up as an ordinary case for rubber, using care to make the base plate smooth and just as you want the plate to be when finished. This will save much time in finishing. Invest the case in the half of the flask having

the guide pins, leaving only the base plate or base plate and teeth exposed (Fig. 1101).

"For the investment, use plaster three parts, and pulverized pumice stone one part. After hardening, trim carefully, and cut a groove from each heel to the pouring gates, dust the surface with powdered soapstone, then add other half of flask, and bolt; place pledgets of cotton in the pouring gates and fill, being careful to avoid air bubbles.

"When the investment has hardened, warm slightly, not enough to melt the wax, separate and carefully remove the wax. Cut grooves at

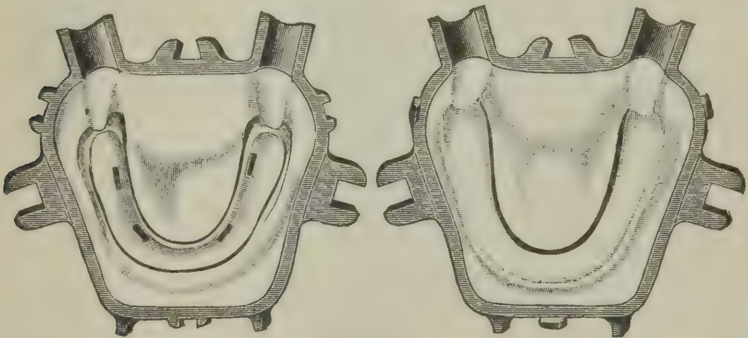


FIG. 1102.

heel corresponding with grooves in lower half, indicated by projections made by lower grooves (Fig. 1102).

"Place parts of flask together and carefully dry in oven or otherwise until moisture will not condense on a cold mirror placed over the vents.

"While the flask is still warm, melt an ingot of the metal in the ladle without stirring or shaking it. Do not heat the metal very hot. Simply watch the ingot until it is entirely melted and pour in a gentle, steady stream, stopping the instant it appears in the other opening. Do not jar or handle the flask until it has cooled, and use the melting ladle for nothing else.

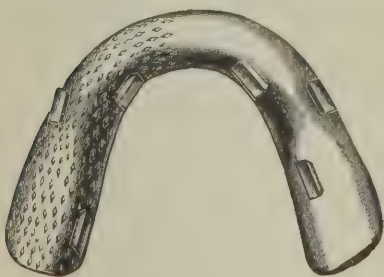


FIG. 1103.

"It is a good plan to pack molding sand around the flask, or lute the joint with moistened kaolin just before pouring, to prevent the possibility of the metal escaping between the two parts of the flask.

"When nearly cold place the flask in warm water for a few minutes and remove the plate from the investment, cut off the surplus metal with a fine saw and finish in the

usual manner. Fig. 1103 illustrates a lower case ready for mounting teeth, and shows the manner of roughening the plate so the rubber will attach itself more firmly. Fig. 1104 illustrates a finished case

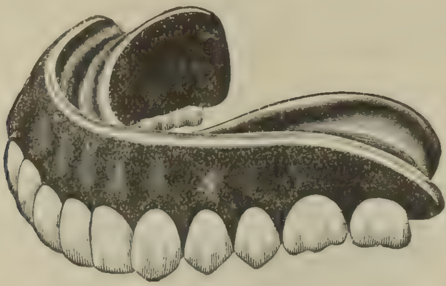


FIG. 1104.

and Fig. 1105 a finished case with rim. Figs. 1106 and 1107 finished cases cast on to gum sections.

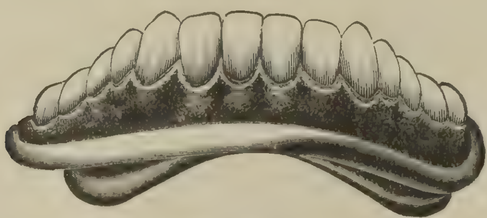


FIG. 1105.

"To repair, cut away metal enough to let the new tooth or block go in place, touch the margins with chlorid of zinc, invest as for a

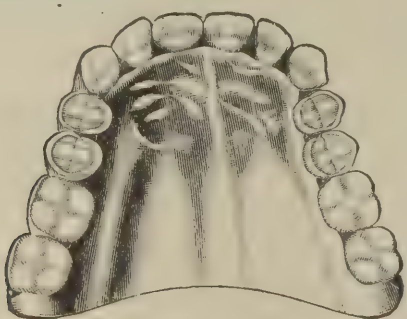


FIG. 1106.

new piece, and pour. When the break is very slight, some mend with a blowpipe, using beeswax as a flux, with the metal as a solder, or,

make an undercut in the region of the pins, fill with rubber, warm the tooth or block, press to place, and vulcanize. It may also be repaired with a small soldering iron, using wax for a flux and Watt's metal for the solder. In repairing the metal should be made hotter than for casting a new case.

"Most beautiful upper or lower plates may be made by combining

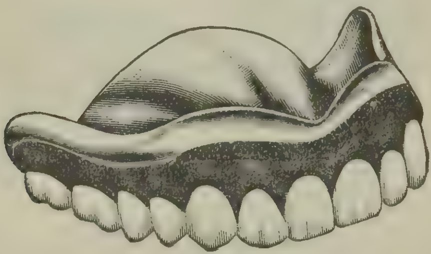


FIG. 1107.

it with rubber or celluloid, when there would be too much weight in using the metal alone."

When the process of constructing artificial dentures of these alloys is properly conducted from the beginning up to the point of pouring the metal, the piece will come from the matrix perfect in all its parts. But when the metal fails to flow freely around the teeth, and to cover perfectly the alveolar border and palatine arch, it is better to replace

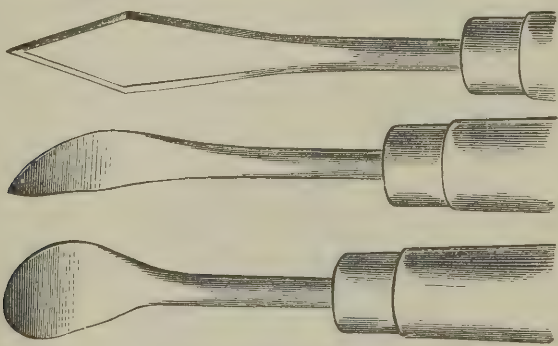


FIG. 1108.

the removed half of the matrix; then, turning the gate down, heat it up to the melting-point of the metal, place again in the sand-bath, and pour a second time. Attempts are sometimes made to patch the plate where the defects are small; but it will prove far more satisfactory in the end to pour it entirely anew. The matrix should become entirely cold before any attempt is made to remove the piece; otherwise there

will be danger from the sudden exposure of warm teeth to the air. The plaster mixture is easily cut; dipping it in water will make it softer and more easily removed.

If care has been used in shaping the wax plate, if the plaster has been kept free from air-bubbles, and if the joints between gum teeth or blocks have been nicely jointed and filled on their front edge, with

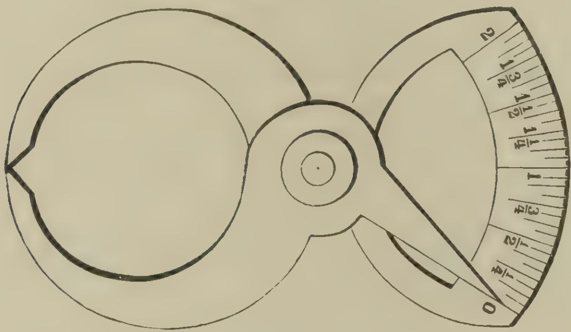


FIG. 1109.

the plaster moistened with soluble glass, the piece may be finished with little trouble. The gates and vents and irregular edges of the plate may be sawed off or removed with coarse files; fine-cut files became clogged with the metal. Scrapers (Fig. 1108) may be employed for removing the roughness of surface—curved or rounded for the inner surface, flat, straight-edged, and pointed for outer surfaces or

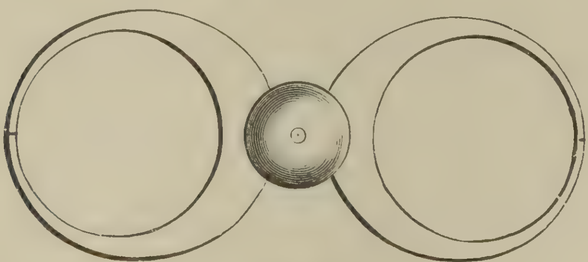


FIG. 1110.

dental interstices. If carelessness in making the wax plate renders it necessary to cut away much thickness of metal the lathe burs used for vulcanite will be found useful. In reducing the thickness of plates frequent use of calipers (Figs. 1109, 1110) is necessary to avoid the accident of cutting through the plate. This is especially apt to happen in the use of lathe burs. Fig. 1110 should have the tips on one side pointed, as in Fig. 1109, and they should be occasionally exam-

ined to see if both sides come together alike. It will make the use of calipers more easy if the arms are kept permanently open by an elastic band, closing by pressure of the fingers at each trial of the plate. Graduated calipers are useful also for measuring the depths of articulating rims, the length of teeth, etc., and are quite indispensable. This done, the surface is rubbed first with coarse and afterward with fine emery cloth, then washed in soap and water with a hard brush, afterward burnished and finished by polishing with chalk on a brush wheel; coarse Scotch stone may be used in place of the emery cloth. The upper surface of its plate must neither be scraped nor polished, as the accuracy of the adaptation to the gums and palatine arch would be injured; it should simply be washed well with a brush, using, perhaps, a little whiting. Every other part ought to be finished in the neatest and most perfect manner; the piece is put in a strong solution of caustic potash, boiled for two or three minutes, then washed in pure water, wiped dry, and finished with chalk and the brush wheel.

Under no circumstances should the tin alloy be gilded. The least imperfection of the electrotype deposit, or the abrasion of any edge of prominence, or the removal of the coating by trimming the plate at any point, presents to the fluids of the mouth two metals having widely different galvanic relations; electric action is inevitable, causing decomposition of the plate, annoyance to the patient, and often ulceration of the gum. The tin alloys are quite harmless in the mouth. They all slightly tarnish, but the surface oxid seems to protect from further action, except where abraded by the mastication of food. The brilliant polish of new work cannot be kept so long as on a gold plate, because it is much softer; this, however, is of secondary importance, provided the metal is hard enough to resist wearing away under the necessary operations of use and of cleansing.

In mounting a set of teeth for the lower jaw the gate through which the metal is poured into the matrix should have two lateral branches, one on each side, to admit the metal more freely. The wax plate should also be thicker, to give sufficient strength and stability to the base; in other respects the process is the same as that described for an upper set. For a partial lower set of molars and bicuspids on each side the wax plate should be extended behind the remaining front teeth; and two or three thicknesses should be applied here, giving stiffness sufficient to prevent breaking or bending under the pressure of mastication.

In making an antagonizing model for an entire set of teeth the wax plate for the lower jaw is stiffened by the adjustment of a stout iron wire, bent to the curvature of the arch, and made fast to and partly bedded in the plate. The rim of wax is now arranged on the ridge,

and after being properly trimmed it is taken from the model. Upper and lower plates are then adjusted in the mouth, the articulation is obtained, and the articulator (Fig. 1111) made in the manner described for a full set of teeth mounted on gold plate. Fig. 1112 represents a double set of teeth arranged in wax upon a plaster articulation, ready to be placed upon their respective models preparatory to the formation of the remaining halves of the matrices. The cast base process is also applicable to partial sets of teeth; a single tooth or several teeth situated in different parts of the arch can be replaced, and retained so as to occasion no inconvenience or annoyance to the patient. The only precaution necessary to be observed in their construction, in addition to that of accuracy of adjustment and neatness of execution, is to thicken the projections of the wax plate between the remaining natural teeth sufficiently to give strength to the metal at these points. These portions, when very narrow, should have twice the thickness of the other parts of the plate. Clasps cannot be used,

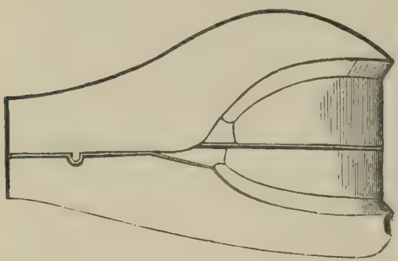


Fig. 1111.

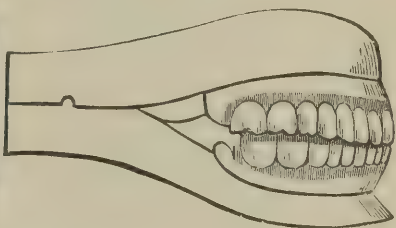


Fig. 1112.

as the metal itself has no elasticity, and gold clasps could not be connected to such plates. With this exception the forms of partial pieces for this work are the same as for vulcanite work, hereafter described. After having adjusted the artificial teeth and made them fast to the wax plate the teeth of the model should be cut off before making the other half of the matrix, as it would be almost impossible to separate the two halves without breaking the teeth and other important parts.

But if proper flasks are used it is not necessary to cut off the teeth. In the same manner as hereafter described for that work, the model may be set in the deep half of the flask until the edges of the teeth are nearly or quite level with the edge of the flask; the investing plaster supports the outside of the teeth and prevents breakage on separating the flask.

A piece from which one or more teeth have been broken can be easily repaired. If any portion of the tooth remain it is removed, and the metal that united it to the base filed away; a new tooth is

selected and ground until it corresponds with the adjoining teeth ; it is then put in place and wax applied on the outside and inside of the tooth, smoothing it with the warm wax-knife evenly with the plate. The apex of a conical-shaped roll of wax about an inch and a half in length is united to the wax on the back part of the tooth ; the apex should be little more than an eighth, and the base half an inch in diameter, which latter should be half an inch above the edge of the teeth. A small stem of wax is united to the wax on the outside of the tooth with the free extremity half an inch above its edge. The one-half of the flask is now filled full of the plaster mixture, and the piece put immediately in it with the base downward, first filling the irregularities of the plate with the plaster ; the top or other half of the flask is then put on and a thin mixture of the same composition is poured on top, filling the ring and covering the edges of the teeth about a quarter of an inch. When hard the projecting stems of wax are withdrawn ; the wax on each side of the tooth and between it and the base will be melted and absorbed during the drying process. The matrix is dried in a stove or furnace, being careful not to heat it up to the point of fusion of the plate. The alloy is then melted and poured into it through the gate behind the tooth, and if it flows, filling the vent in front without bubbling, the piece will come from the matrix perfectly restored. When cold the plaster mixture is broken from the teeth and the metal around the new tooth finished according to the direction given for full sets. In repairing pieces the heating of the matrix and metal must be done very carefully. If the matrix is too hot, the plate may fuse ; if too cool and the melted metal too hot, the porcelain may be cracked. In using tin alloys in connection with platina pins it should be remembered that the exposure of a single rivet to the action of the buccal fluids forms a galvanic battery, which will cause an unpleasant taste and render the piece liable to slow decomposition ; hence all pins must be carefully covered with metal, so as not to be exposed in the finishing processes.

Sets of teeth may be made of these alloys which, after cutting off the gate and vents, are ready for the emery-cloth and brush-wheels. This result can be uniformly secured by care in shaping the wax and proper attention to temperature in pouring. These alloys have a slight shrinkage, not sufficient to break blocks or chip the edges if the directions above given are observed. The slight shrinkage may give these plates an advantage over vulcanite in point of adaptation.

The strength of the Wood or Weston metals permits their use for partial pieces and allows stays to be formed on the plate ; but full clasps cannot be made because alloys of this class are not sufficiently elastic. The form of such plates will be discussed in the next chap-

ter. In preparing the above directions we have discarded some innovations upon other processes as being anything but improvements; such, for instance, as the recommendation to heat to 210°, or, "so that it can hardly be held in the hand," a flask containing teeth on to which a metal is to be suddenly poured at a temperature of 440°. This temperature may be quite sufficient, however, for some of Dr. Wood's alloys. The safest rule in all cases, except for repairs, is to heat up to the fusion point of the alloy. As an offset to this error we notice a good suggestion for removing small remnants of wax by washing out with hot water. It has an advantage over the plan of allowing the hot, dry plaster to absorb the wax, in permitting examination of the pins and joints and allowing closure of front joints with plaster; also by enabling the mold to be thoroughly cleansed just before closing it prevents the accidental retention of small particles of plaster which may interfere with the flow of the metal.

Aluminum or *Aluminium Work.*—This metal is in nearly all works on chemistry called Aluminium, making it similar in termination to twenty-three other metallic bases discovered by modern science and known by Latinized names ending in *ium*. None of these, however, have any practical value in the arts as metals, except cadmium, magnesium, palladium, rhodium, and iridium.

Sir Humphrey Davy inferred from his discovery of sodium and potassium that alumina was the oxid of a metallic base. This conjectural metal, named Aluminium, was subsequently discovered by Wöhler, but remained for more than twenty years a mere chemical curiosity, until in 1854 St. Clair Deville succeeded in manufacturing it in large ingots by the action of sodium upon the chlorid of aluminium; but the cost of metallic sodium made this an expensive process. He subsequently obtained it by the action of chlorid of potassium upon the once rare mineral, Cryolite—an alumino-fluorid of sodium, large deposits of which have been discovered in Greenland.

It is the lightest metal known except magnesium (excepting also, of course, sodium and potassium); its specific gravity is 2.56 for cast metal and 2.67 for hammered metal, about the weight of glass or porcelain. Its point of fusion is somewhere near 1000° Fahrenheit. It is malleable, laminable, and ductile in a high degree; has a hardness equal to silver and excels it in point of tenacity; it is eight times better than iron as a conductor of electricity, being nearly equal to silver. Unlike silver, it wholly resists the action of sulphur, also of nitric acid, unless it is boiling. Sulphuric acid does not affect it, nor do the vegetable acids, as citric, oxalic, and tartaric. Its proper solvents are hydrochloric acid and chlorin. It is somewhat affected by the caustic alkalies, soda, and potash; also, perhaps, by ammonia and

quicklime. A solution of salt and vinegar is said to affect it, possibly due to a liberation of the chlorin in the salt.

Its record of resistance to change by acid and alkali is a very fair one, and gives rise to the conjecture of possible impurity of metal in explanation of the cases reported in which aluminium plates undergo change in the mouth. The conjecture is strengthened by the peculiarity of this change; it occurs in spots, seeming to indicate some local impurity or alloy, not by a general discoloration of the plate, such as we see on eighteen-carat gold, or silver, and on the stannic alloys. The subject of aluminium alloys in connection with the mouth and as solders is an open field of inquiry, and researches may some day be crowned with the discovery of an aluminium base plate equal in all respects to gold plate, with the peculiar advantage of its remarkable lightness. Present experience is unfavorable to its power, in its pure state, of resisting the buccal secretions.

Aluminium plates may be swaged, teeth backed and soldered by the blowpipe, just as in gold work, but its soldering requires great care. For many years all formulæ of solders for this metal proved very unsatisfactory, and but recently it was discovered that the chlorids of silver and cadmium acted well as fluxes in soldering aluminium. The most successful solder which has attained any extensive use is that of Joseph Richards, of Philadelphia, which can be used with the blowpipe or with a soldering iron.

When used with the blowpipe or soldering iron, the surfaces to be united are first scraped clean and then tinned with the solder itself by rubbing it on hard with the copper soldering iron; the prepared edges can then be easily soldered together, using the hot copper iron and no flux. This solder consists of an alloy of zinc, tin, aluminium, and phosphorus, the zinc and tin constituting the bulk of the mass. When this solder is to be used with the blowpipe, a little silver can be added to it to give a better color. The swaging of aluminium is done just as in the case of gold or platinum, except that frequent annealing is necessary. The annealing must be done with extreme care, since the fusion point of the metal is so little above red heat that the slightest excess of heat will warp, blister, or melt the plate. For the purpose of annealing it is suggested to coat the surface of plate with oil, and then pass it over the flame of a spirit-lamp until the oil is burned off and the plate becomes white, when it is instantly withdrawn. The extreme lightness of this metal permits the use of a plate two or three times the thickness of gold plate; hence aluminium plates may be the very strongest that can be made in any given case. The best method yet proposed for attaching the teeth to such a plate is by vulcanite, the details of which process will be given in the next chapter. It is a

peculiarity of pure aluminium that vulcanized rubber adheres to it with great tenacity. A set of well-chosen block teeth, skillfully arranged and secured to an accurately fitting aluminium plate, may safely be offered to the most fastidious and critical patient. It has, moreover, the great advantage that "sixty-minute" dentists will not care to imitate work which takes "several" hours to do even passably well.

Another form of aluminium work, and that which has led to the present classification of this metal under the head of Plastic work, was the molded or cast aluminium plate. No experiments, however, seem to us to have been conducted with such care as those of the late Dr. James B. Bean, of Baltimore, who perished under an avalanche, in the summer of 1870, while ascending Mont Blanc; and his process was not only a difficult one to pursue, but was very uncertain in its result; hence the use of aluminium is not at the present time attempted except in the form of swaged plates to which the teeth are connected by vulcanized rubber, and which is referred to in the article on Vulcanite.

Aluminium Cast Base.—Dr. C. C. Carroll uses a prepared form of aluminium which he describes as being first made pure to prevent disintegration, and then alloyed with a small per cent. of noble metals that expand in cooling and thus compensate the contraction of the aluminium. He describes his method as follows:—

"*For a Rubber Attachment.*—Base No. 1: Take an accurate impression in plaster, or modeling composition, outline on the impression the limit to be covered by the denture as intended to be worn. Place a strip of our No. 1 base plate wax, ½ inch wide, across the posterior palatine arch of the impression, terminating and shading out at the alveolar palatine border. This wax strip, when reproduced in aluminium, closes the posterior palatine arch of the cast denture, which by virtue of the slight contraction of $\frac{1}{120}$ part impinges firmly on the alveolar ridge, while it lifts slightly from the central posterior arch, making a denture that rests firmly in place without rocking. Pour the impression thus prepared with our investing compound mixed to the consistency of thick cream, and get a model, on which cut a narrow line $\frac{1}{32}$ inch deep and the same width, extending from the wax strip imprint around the alveolar palatine border, to constitute all the air chamber that should ever be made in an aluminium cast denture.

"Take a thin sheet of our No. 1 wax base plate, about No. 23 standard gold gauge in thickness, and shape neatly on the model a temporary base plate as intended to be worn. Surround the entire palatine and labial alveolar border, near to the line that the teeth are to occupy, with a thin strip of paraffin wax about ⅛ inch in width;

fasten and smooth down the outer edge of this strip with melted wax; then with a thin wax knife raise the inner edge all around next where the teeth are to be arranged, which wax strip, when reproduced in the metal base plate, will be a flange or undercut, surrounding the teeth to hold the celluloid or rubber attachment for fastening the teeth to the permanent metallic base plate.

"Contour, carve, and smooth neatly to the form desired. Now make the matrix by imbedding the model with the temporary base plate upon it, in the female part of the flask, allowing the investing

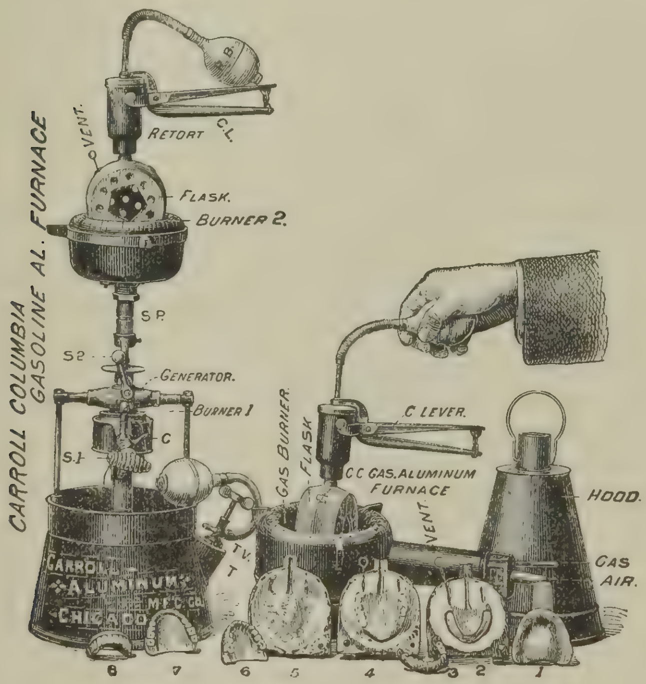


FIG. 1113.

material to come up to the edge of the base plate. When set, smooth the investing material and cut a gate from the middle edge of the base plate to the pouring point of the flask; also cut short gates about one inch long in a perpendicular line from the heels. The gates, when finished, should be nearly round, about $\frac{3}{16}$ inch in diameter. Connect one gate with the vent cut in the flask.

"Dust the surface of the matrix with pulverized soapstone, and polish the surface by rubbing with the finger. Mix enough investing mate-

rial to fill the other half of the flask ; pour first so as to cover the base plate and matrix, jar to expel the air, and then pour into the male part of the flask, place the two parts carefully together, and force into place, squeezing the excess through the perforated back of the flask. When set and hard separate and remove the temporary base plate, washing out the wax with hot water. Take great care that the wax is not melted before separating, and absorbed into the matrix to generate gas that will prevent a perfect cast of aluminium.

"Cut the gates in the male part of the matrix, as indicated, to correspond to the female part. Cut out the plaster from the pouring point. Bolt the flask firmly together. Coat the thread of flask with soapstone. Screw the retort firmly to flask. Place the fine copper wire in the vent. Then lute the seam of the flask and where retort joins the flask, also around the bolts, with investing material, to prevent the escape of air or metal in casting. Test with the rubber bulb and clamping lever. See if matrix is air-tight. Soapstone sprinkled over suspected leak will determine the test. Withdraw the wire from the vent and test again to see that only the vent is open. Place the flask in the slot of the burner, turn on low flame, and dry out thoroughly, as will be shown if no moisture appeers on the surface of a mirror held over the retort.

"When the piece is dry, place the flask on the bottom of the burner; put two ingots of Aluminium Base No. 1 in the retort, place the hood over it, and turn on full flame, and with use of foot bellows attached to air tube of the burner proceed to melt the metal, which will usually require from six to ten minutes.

"When melted, remove the hood, turn off the gas, and clamp the retort cover in place with clamping tongues, slipping the ring over handles, then with the rubber bulb pressed gently but firmly force the melted metal into the matrix, until metal is forced through the matrix at the vent; chill the metal with piece of wet sponge tied to a stick as soon as it appears at the vent. Press three seconds to condense the metal under pressure in the matrix. Make an ingot mold by filling a pepper box with investing and boring a tapering hole of less diameter than the retort. With the handles of the clamping tongs unscrew the retort from the flask as it stands in the burner, and with bulb blow out all excess aluminium from the retort, so that the opening through the bottom is clear.

"*For Casting Directly on Teeth.*—When it is desired to cast directly on plain teeth, which are preferable to section teeth, place the model prepared as above described upon the articulator, after obtaining a correct articulation in the usual manner. Mount the teeth on the No. 1 wax base plate, as is usual for rubber work, except that the teeth

must be spaced so that a postal card will pass between them when mounted. Wax up contour and carve neatly, with a double curved end wax knife, exactly as intended to be worn, leaving the lingual surface of the wax base plate unmarred as you would have the aluminium plate come out finished, remembering that the wax form will be accurately reproduced in aluminium.

"If it is necessary to have an artificial gum, which very rarely happens if plain teeth of the proper pattern are selected, then place a narrow strip of base plate wax, $\frac{3}{16}$ inch wide, around the alveolar border only, for a flange, between which flange and the ends of the teeth a pink rubber facing may be attached.

"Remove the model with the mounted denture and proceed to invest as described for a base plate alone. After washing out the wax, make a thin cream of equal parts carbonate of magnesia and prepared chalk, with water, and with a small camel's-hair pencil cover the alveolo-labial edge of the teeth with a thin coating of this cream, to prevent the metal from flowing over the edge and possibly checking the teeth.

"Bolt the flask together and dry out the case, and make cast as directed for base plate.

"If the gum section teeth are used, grind the feather edge slightly beveled, leaving the labial edge of the gum highest, and mount, spacing slightly by placing heavy writing paper between the joints. Before investing, remove the paper and flow between the joints the magnesia and chalk cream above given. Then invest the same as for plain teeth. After washing out the wax, flow a thin film of the above cream along the beveled edge of the gum, close the flask, dry out, and proceed to cast as directed.

"If at any time the crucible passage becomes stopped, before making another cast heat the crucible to a bright red and blow out the obstruction; otherwise metal being left near the outlet of the passage would form a siphon, and empty the chamber of any metal in it designed for a subsequent cast.

"Let the cast cool slowly; separate the flask and remove the cast from the investment. With a fine saw and cutting pliers, trim away all surplus metal from the cast. Coarse finish with files, cone burs, and sand paper. Burnish and remove scratches with pumice and water, and finish with polishing compound on brush and buff wheels.

"If a base plate has been cast, use this finished base plate for a trial plate; with wax placed along the flanged alveolar border, obtain the correct bite and articulation. Mount the teeth as desired, waxing up for celluloid or rubber attachment, and proceed as in celluloid or rubber work.

"*Directions for Base No. 2.*—Proceed in all respects as if for rubber work, using thin paraffine wax for temporary base plate until the teeth are mounted on the model. Trim and wax up neatly and light as intended to be when finished for the mouth. Then invest the model and the teeth in perforated flask and proceed as directed for Base No. 1 up to the point of making the cast. When the matrix is dry and ready to make the cast, place two ingots of Base No. 2 in the retort with the larger opening. Stop the opening with an old plugger to prevent the metal escaping as it melts. When all is melted withdraw the stopper and chill the metal when it appears at the vent. Turn on flame enough to melt the metal in eight to ten minutes, which requires not over half the flame needed for Base No. 1. If there should be any point of leakage of metal it can be stopped at once by touching it with a wet cloth, and any escaped metal can be immediately remelted and poured into the matrix without producing any flaw or imperfection in the piece to be cast. Let the piece cool slowly, remove from the flask, and finish as directed for Base No. 1. Never use the same retort for melting Base No. 1 and Base No. 2.

"*For Aluminium Crown and Bridge Work.*—Shape the roots or teeth to which attachment is to be made for crowns or bridges the same as for a gold crown and bridge work. Then take an accurate impression in plaster, if possible, from which make a model of investing of the part to be supplied. Mold upon the supporting roots or teeth in thin paraffine wax the crown or bridge as intended to be worn, and mount the teeth desired to supply the needed deficiency with proper occlusion, in the same manner as if a partial plate were to be made, taking care to space the teeth so they shall not touch each other if the bridge is to be cast from Base No. 1. Carve neatly as intended to be worn, allowing the bridge or saddle to rest narrowly on the alveolar border, which should be slightly scraped on the model so as to fit firmly on the soft parts and thus distribute the force over the supporting roots and the alveolar border alike, at the same time precluding food from getting under the bridge or saddle. Now invest or proceed with the subsequent steps as already described for casting, according as the case may be for Base No. 1 or No. 2. Finish and adjust to the mouth either for detachable or cemented bridge, as may be desired—giving the preference to detachable bridge work when practicable. If it is to be cemented, use oxyphosphate of zinc, mixed as if to be used in filling; dry the roots or teeth to be crowned; fill the crowns; press the bridge firmly to place, keeping dry until fully set, which operation may be expedited by the use of hot air. Removable bridges and partial dentures are securely held in place by the Carroll Spiral Aluminium Coil Spring.

"*Directions for Using Gasoline Furnace.*—Use 74 degree specific gravity gasoline, fill the tank about half full, close all the openings, pump in air, open vent to the dripping-pan, S^1 (see Gasoline Furnace, Fig. 1113), swing around the cut-off to the dripping pan (C), and fill about two-thirds full, which you light to heat the lower generator; when dripping-pan is burned out, swing cut-off back and open lower generator and light the gas under large generator B^1, which let run for about five minutes, then open upper generator at S^2 and light the gas at the burner B^2, keeping the lower generator burning just high enough to heat the upper generator while in use. Keep water in the reservoir above the tank in order that the tank may not heat. Mount, invest, and cast as directed for gas outfit."

Gold Alloy-Cast Base.—Dr. G. F. Reese has recently devised an alloy composed of gold, one part; silver, two parts; and tin, twenty parts, which is manipulated by a special method, as a base for artificial dentures, and which has met with considerable favor. A brief description of Dr. Reese's method is as follows: A plaster model is first obtained from a plaster impression of the mouth, and on the model a trial plate is made of gutta-percha, paraffin, and wax, or of modeling composition. Upon this trial plate the teeth are arranged and tried in the mouth. If satisfactory the waxing about the teeth is completed, and the portion of the trial plate covering the palatine surface is removed to such a degree as to nearly expose the pins of the teeth, the wax under the gums being allowed to remain. For the portion of the trial plate removed two thicknesses of French flower wax is substituted, being carefully adapted to the model.

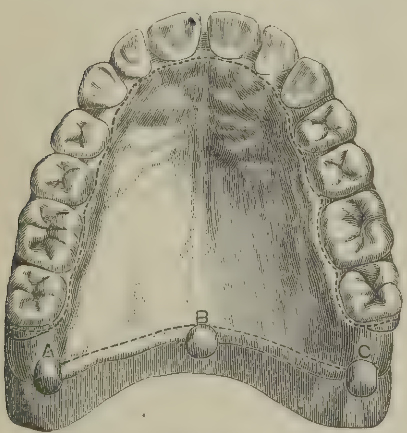


FIG. 1114.

Fig. 1114 represents a case carried to the stage described, the dotted lines showing the edges of the thin wax substitute portion, and B, A, and C prominences of wax attached to the posterior border and portion of the plate covering the maxillary tuberosities, A and C being designed for the escape of the alloy, which is poured in at B. The case is then placed in a brass flask, which has been oiled to render its removal from the investment easy. Fig. 1115 represents the case in the flask ready for investment. To invest the case each section is placed

upon a plate of glass and plaster poured in until it is half filled, when the model, which has been saturated with water, is pressed into the plaster batter until the teeth and gums alone remain uncovered. The counterpart of the flask is then set on and sufficient plaster poured in until the prominences of wax along the posterior border of the trial plate are slightly covered. After the plaster has set the upper section of the flask is removed and the surface of the plaster coated with shellac varnish. The section of the flask is then returned to its place and the investment completed by filling it up to the edges with additional plaster. When this has set the flask is placed in hot water in order to separate the sections easily. The wax is then removed and also the

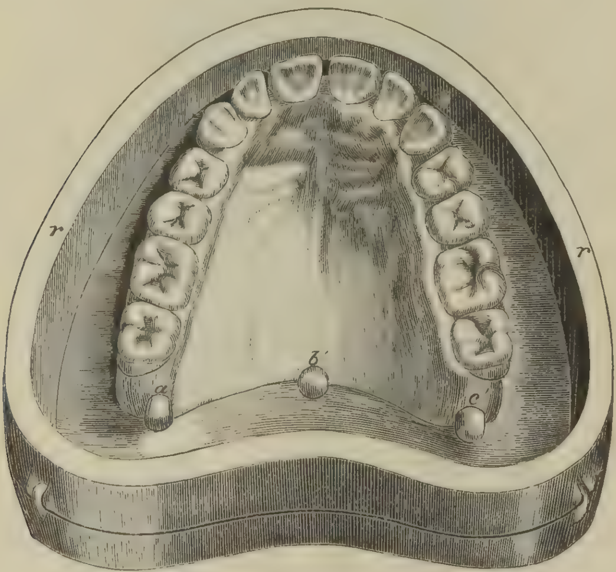


FIG. 1115.

sections of the flask by gently tapping them, and communication made from the outer surface with the cavities left by the wax prominences along the posterior border of the plate; or, if this is impossible, the vents and gates may be formed at the line of division between the sections, as represented by the dotted lines in Figs. 1116 and 1117. Externally the openings D, E, and F, Fig. 1117, should be enlarged by reaming out the plaster and varnished with shellac, to receive the cylinders, which latter are made of wax, rolled thin, and wrapped around a cone-shaped piece of wood. These cylinders are about one and a half inches long and about half an inch in diameter at the base, tapering to an eighth of an inch at the apex.

The pouring-cylinder is usually made somewhat smaller at its base than the others, but some two inches long. Wax covers are attached by a warm spatula to the larger ends of the cylinders, so as to make them water-tight. Fig. 1116, *d*, *e*, *f*, shows the cylinders thus prepared and attached. In case the openings have been made through the plaster investment of the lower section, as represented in Fig. 1116, then the upper section, Fig. 1117, need not be united to it

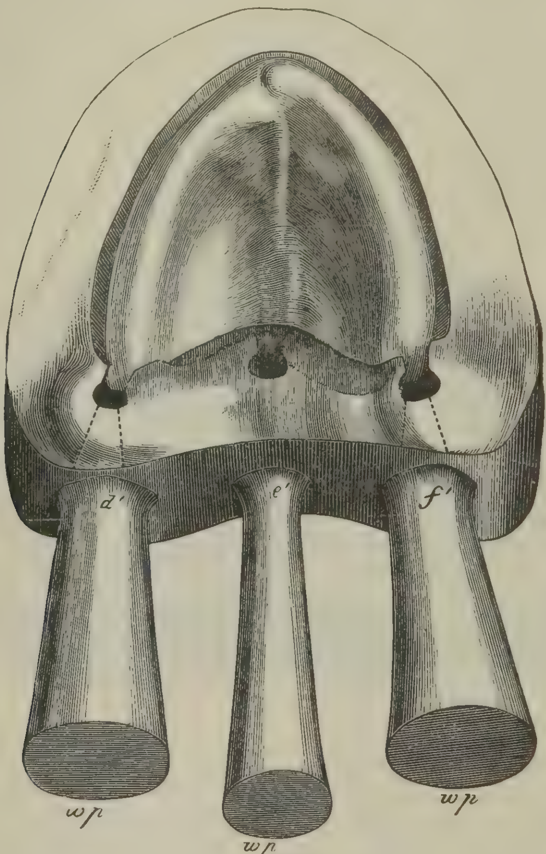


FIG. 1116.

until the openings have been formed upon the line of division, when the sections must be joined before the cylinders can be attached. The case is then placed in a larger flask, Fig. 1118, and invested as before, allowing the end of the pouring-cylinder to rest in the opening of the posterior border of the flask. In this investment there is no division of the sections after the parts of the flask are filled. The case is then

dried in an oven, all of the wax being absorbed by the heated plaster, until all moisture is expelled. Several grades of the alloy are used by Dr. Reese, which melt at 600° to 700° F., but a higher temperature is

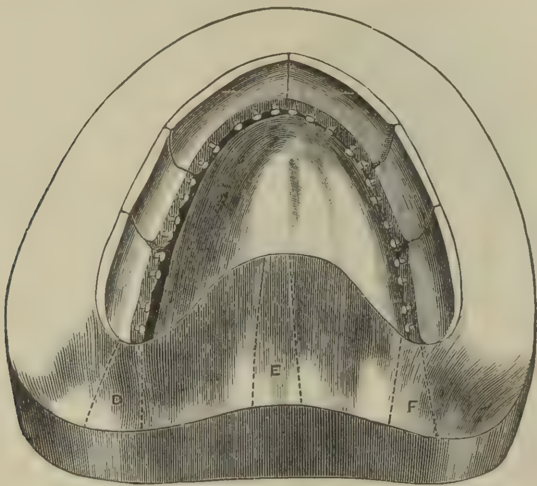


FIG. 1117.

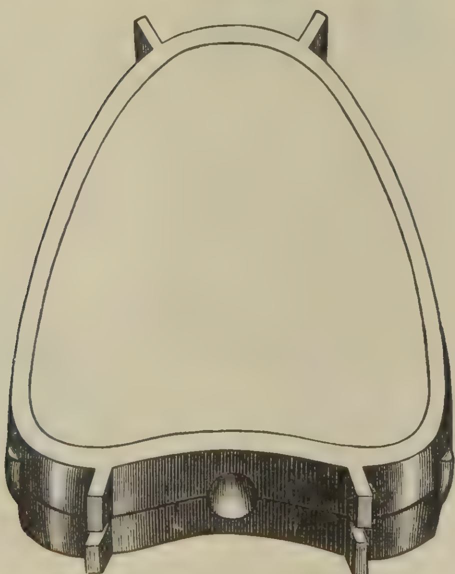


FIG. 1118.

necessary before the metal is ready to pour. A temperature of 900° F., however, will cause rapid oxidation, which, of course, should be

avoided. An ordinary ladle may be employed to melt the alloy, which is poured at the proper temperature into the opening of the flask and investment. When sufficient time has elapsed for the metal to cool, the flask is opened and the case presents the appearance represented by Fig. 1119, when it is ready for finishing, the surplus alloy being removed by a saw, and the surface of the plate polished by pumice on a wheel and brush.

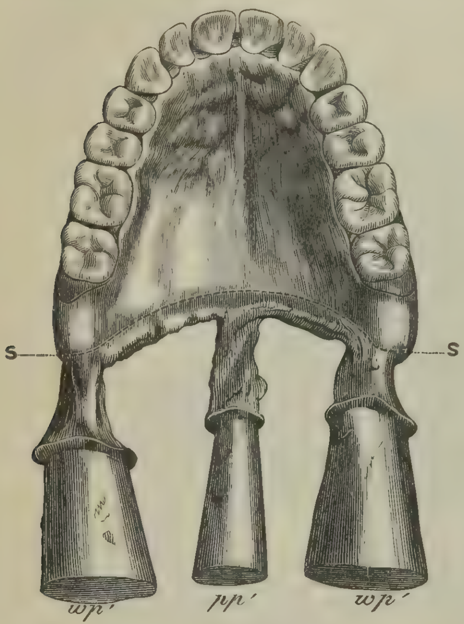


FIG. 1119.

To repair this work all edges are scraped clean, and a space cut between them of about one-eighth of an inch, which is filled with wax when the set is adjusted on the model. At each end of the space two cones of wax, each about one-eighth of an inch in diameter, are attached, standing perpendicularly to the palatal surface, and the whole invested with plaster to the depth of an inch. The two sections thus made are then separated, and the wax is washed out by boiling in hot water. The external ends of the spaces left by the wax cones are then countersunk and a larger wax cone is inserted into each opening, the one to form a pouring-gate and the other to act as a vent for surplus metal, this last being entirely covered by the plaster of the investment. The entire piece is then invested in a repair-flask, and the plaster thoroughly dried and heated up before the alloy is poured.

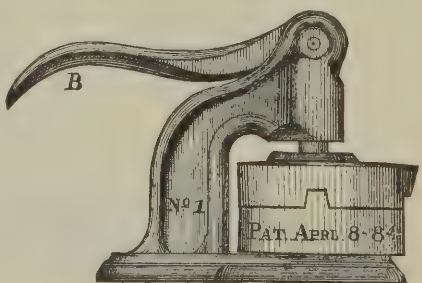


FIG. 1120.

Fig. 1120 represents a dental mold designed by Dr. Hayford for use in manipulating Weston's, Watt's, and Hayford's alloys and by which it is claimed all imperfections caused by air bubbles or failure of the material to cast sharply

are overcome. The metal is introduced with the flask partly open, and just before crystallization commences pressure is applied by means of the lever, which closes the flask and forces the material into every portion of the mold, producing a sharp, perfect casting.

Ward's Electro-Metallic Dentures.—A process of depositing by the action of a battery gold and silver directly upon the surface of the plaster model obtained from the impression of the mouth, and thus securing perfect adaptation, has recently been introduced. The surface of the plaster model is prepared for the deposit of gold by coating it with plumbago. A definite thickness of gold is first deposited on the plumbago-covered surface of the plaster model, and upon the gold a deposit is then made of silver, which in like manner is then covered by another deposit of gold. The object of using silver as an intermediate layer between the two gold layers is to give strength to the plate, as all deposited metals are deficient in that respect, but silver less so than gold. Sometimes a thin silver plate is swaged and the gold deposited upon it. Any desired thickness of gold can be deposited. If a rim is desired on the plate the edges of the impression are cut down and shaped accordingly before the model is poured. A plate so constructed must not be soldered, as the heat will anneal it to such a degree as to render it too pliable; hence in a set of full metal the teeth are attached by depositing gold about and around their pins, and the backings are portions of the deposited metals and continuous with the plate. This process is applicable for full and partial dentures of all metal finish and for combination with rubber or celluloid, in which case a portion of the surface of the plate—that covering the alveolar ridge—is so formed as to present projections of the metal in the form of retaining-points for securing the vulcanite or celluloid which attaches the teeth and forms the gum portion. It can also be applied to capping crowns or cusps and to removable bridge-work.

VULCANO-PLASTIC WORK.

Under this name are included all vegetable materials which have been, or may hereafter be, incorporated with sulphur, iodin, or other substances for the development of those peculiar properties so well known in hard rubber. Inspissated linseed oil, amber, and gum copal, etc., have thus been experimented with, but with results thus far very unsatisfactory. They are here mentioned because it is by no means improbable that among the vegetable oils, resins, or gums, now known or to be discovered, there will be found one which shall excel any yet known in those remarkable qualities imparted by sulphur to the resinous gums, gutta percha, and caoutchouc. These differ from some other resins in an opacity which follows them through their

combinations with sulphur, making it impossible to obtain even a tolerable imitation of mucous membrane. Possibly some as yet unknown vulcanizable transparent resin may be found carrying into its combinations enough of translucency to give that peculiar, life-like animation which now characterizes porcelain-gum colors alone. The history of caoutchouc teaches us that it is not impossible we may be in daily use of some such gum or resin. The only compounds of gum (more strictly, resin) and sulphur that have been tried to any extent are corallite and vulcanite—the trade names of sulphuretted gutta-percha and sulphurated caoutchouc; also spoken of as sulphid of caoutchouc, because the new properties developed by the union are such as make it appear to be a true chemical compound, and not, like the vermilion, etc., often incorporated with it, a mechanical mixture.

Corallite.—Gutta-percha is the resinous exudation of a forest tree, the *Isonandra Gutta*, found extensively in Sumatra, Borneo, and the Malayan Peninsula. It was first brought to the notice of the Europeans by Dr. Montgomerie, of Bengal, in 1842, and in a few years attracted much attention for those valuable properties which have since made it so indispensable to the dentist. Twelve years ago experiments were made with it in combination with sulphur. Combined with half its weight of sulphur, and the compound then mixed with half its weight of vermilion, it formed a substance known as "Corallite," which hardened under the same conditions as vulcanite, and of which it promised to become a formidable rival.

Unfortunately, one property of crude gutta-percha followed it into this combination—its tendency to become brittle. It is well known that sheets of this substance, whether the pure crude gum or that prepared for dental use by large admixture of foreign matter, will become in time so brittle as to break almost at a touch. The vulcanized gutta-percha has the same property in less marked degree, but quite enough so to be fatal to its pretensions as a rival of vulcanite. Hence corallite is no longer avowedly used, and even its name is almost forgotten. So persistent is this injurious property that it will affect any rubber compounds with which it may be mixed. Any suspicion of the presence of gutta-percha should condemn sulphurated caoutchouc for dental use; this last-named gum, however, may be brittle and worthless from admixture of other substances besides gutta-percha, as will be hereafter stated.

VULCANITE.

Caoutchouc, formerly known as elastic resin, and still more universally known as India-rubber, was discovered by certain French Academicians in Cayenne in the year 1735. For many years its only known value was as an eraser of lead-pencil marks. Dr. Priestley, the

distinguished discoverer of oxygen, in the preface to his work on Perspective, published in 1770, speaks of it as being excellently adapted to the purpose of wiping from paper the marks of a black-lead pencil. It was still many years after this that it was confined to this use and to the making of rubber shoes and bottles by South American and East Indian natives, who formed them on clay molds from the fresh exudation of the *Siphonia cahuca Jatropa elastica*, or *Ficus elastica*. Upon discovery of a solvent, its uses were extended by bringing to bear the skilled labor of civilization; but the fact of its becoming hard and rigid (yet not brittle) at 48° greatly limited its value. The principal solvents of caoutchouc are spirits of turpentine, bisulphid of carbon, benzol, ether, chloroform, naphtha, and the essential oils.

Mr. Charles Goodyear's discovery of the remarkable effects of sulphur in combination with caoutchouc has, since 1840, extended the application of this gum to an almost infinite variety of uses. In certain proportions and at certain temperatures the sulphur does not much impair the remarkably elastic and flexible property of the native gum, but preserves it at low temperatures. Subsequent experiments led to the discovery of hard rubber, which at first was made into combs, buttons, etc. It was thus used for a number of years before its application to dental purposes. This was first attempted as early as 1853. Mr. Bevan, a former employee of the Goodyear Company, Dr. Putnam, of New York, and Dr. Mallett, of New Haven, were the first persons known to the writer as engaged in these experiments; possibly others were at the same time thus occupied. But owing to the exceedingly cumbrous vulcanizing apparatus (Dr. Putnam's weighing twelve hundred pounds), and the absence of that knowledge of the material and those appliances for its manipulation which experience alone could give, it made very slow progress for the first few years. It has been estimated that in 1858 not more than three hundred dentists made any use of it; in 1863 it was conjectured by Dr. Franklin (then dental agent for the American Hard Rubber Company) that nearly, if not quite, three thousand employed it in their practice. At the present time, the patents restricting its use having expired, it is universally employed.

Hard rubber possesses, when prepared in greatest perfection, many qualities which fit it for use as a base plate. It is impervious to the buccal secretions and unchanged by them; it has very considerable strength, great lightness, and, when properly vulcanized, a high degree of elasticity. For some purposes in prosthetic dentistry it has no equal and for some few it is indispensable; but the merit of superior adaptation is shared by other plastic substances, and for many cases

we have shown that the fit of an old-fashioned gold plate is much to be preferred.

Dental vulcanite is usually incorporated with vermilion, to give it a color more generally acceptable than the dark brown of the simple sulphurated gum. But rubber, sulphur, and vermilion are all opaque substances, and can never themselves, or by combination with other materials, be made to assume any resemblance to the natural gum, which porcelain alone has thus far been able to imitate. The incorporation of such substances for this purpose has no other effect than seriously to impair the strength of the material. Experiments in vulcanite are much more troublesome than those with stannic alloys, and probably few will take the trouble of making them. A common formula for the red vulcanite is caoutchouc, 48 parts; sulphur, 24 parts; vermilion, 36 parts. The formula for a dark-brown vulcanite is caoutchouc, 48 parts; sulphur, 24 parts; this gives the strongest rubber. The formula for a jet black vulcanite is caoutchouc, 48 parts; sulphur, 24 parts; ivory, or drop black, 48 parts. All colored rubbers are weakened by the addition of foreign matter, as English pink vulcanite, which contains 48 per cent. of white clay. White oxid of zinc in the proportion of 47 per cent. will give to vulcanite mixed with sulphur and vermilion a deep pink color. The pink rubbers are so much weakened by the admixture of foreign matter that care must be taken when they are used to produce a more natural color of the gum portion of a denture, to prevent the pins of the artificial teeth from being covered by such rubber. From an extended series of very careful experiments by the late Prof. Wildman we condense the following statements:—

Caoutchouc two parts, sulphur one part, form a dark-brown rubber, which is the strongest of the vulcanites. Of all additions for modification of color, purest vermilion is best; it withstands heat, resists the action of sulphur, and has an intensity of color that soonest overcomes the darkness of the rubber. Being a sulphuret, it appears to have much less effect in weakening the texture of the sulphid of caoutchouc than an equal quantity of any other substance; yet it does diminish its strength in proportion to its use. English deep red and American Hard Rubber Company's red contain by weight two parts sulphid of caoutchouc and one part of vermilion. To the red and brown rubbers white oxid of zinc or white clay are added in proportions varying from .20 to .57 per cent., to produce grayish-white or pink rubber. Of these the best is Ash and Sons' pink rubber (S. P.), containing gum sulphur and vermilion, in same proportion as English deep red, with one-fourth this weight of white oxid of zinc added to tone the deep color. Black rubber is made by adding to six parts of the brown sulphid from two to four parts of the ivory black.

In the selection of rubbers we unhesitatingly decide in favor of the brown vulcanite, not from any absurd idea of the injurious action of vermilion, which we shall presently show to be perfectly harmless, but because of its superior lightness and strength. We are not justified in sacrificing these valuable qualities for the sake of colors, which not only have no greater esthetic harmony with the mouth, but which by the brilliancy of their color attract attention to this defect. We use white platinum and aluminium and yellow gold; ivory, in old times, soon darkened, and a tobacco chewer will blacken any vulcanite plate. Why not, then, use a brown base plate from the beginning? If the vermilion rubber is used let it by all means have its natural rich mahogany color, and not the glaring brilliancy with which students delight to invest their specimens. This does very well in show cases, and is eminently adapted to those captivating exhibitions of high art where a lovely wax face opens and closes, revealing alternately an aching void and acheless grinders; but in the mouth such bright colors are monstrous violations of good taste.

Vermilion combined with rubber cannot have any deleterious effect. In no case coming under our observation have we seen a single symptom of local or constitutional action peculiar to vulcanite, except a sensation of heat; this we take to be an electric action, due to the fact that rubber, like sealing wax, is a powerful negative electric. It is common to brown, red, pink, and white rubbers, and there is no remedy for it. It is not a constant symptom; some patients never feel it, some often, some occasionally—dependent, perhaps, upon the state of the electric element entering into the composition of vital force.

Pure sulphuret of mercury is reckoned by Orfila as medicinally inert. Fumigation, by *vaporizing* the mercury, gives it a medicinal activity; but this requires a temperature of 600° Fahrenheit. Therefore, for the development of constitutional symptoms, we must have the presence of arsenic or of red lead, as impurities of the sulphuret, or the existence of free mercury.

First, as to the impurities of arsenic or red lead: they are not found in pure vermilion. But even if present such poisonous impurity would be rendered harmless, because completely invested by an insoluble coating of India-rubber. A piece of vulcanite is impervious to the fluids of the mouth; hence no part of its substance can be dissolved and thus taken into the stomach. Any supposed medicinal action must, therefore, come from such minute particles as may possibly be worn off the lingual surface near the teeth, where bread crusts or other hard particles of food impinge. White, gray, and pink rubbers have so large a proportion of foreign matter that they are easily

abraded; but in the pure red rubbers we have thus an almost infinitesimally small quantity of vulcanite taken into the stomach, one-third of which is inert vermilion, adulterated (we will suppose) with three per cent. of arsenic, and this coated with a layer of rubber, which, as previously stated, is insoluble in water, alcohol, alkalies, or weak acids. This very minute trace of arsenic, even if divested of its envelope of rubber, would have a purely homeopathic (and, by consequence, not poisonous) action; while, if encased in rubber, which pervades every part of the material, it is absolutely inert. The same may be said of the less poisonous adulteration, red lead.

Secondly, as to the mercury: the researches of Prof. C. Johnston, with the microscope, and Prof. Alfred Mayer, by chemical analysis, have failed to discover the slightest trace in samples of the best rubber used. Prof. Wildman found sulphur sublimed during vulcanization, but not the smallest trace of mercury. We have failed by any mechanical force to press out any globules, nor have we ever, in any manipulations, seen the slightest particle of this metal, or been able with the microscope to detect it upon the surface of any finished piece. This question of the presence of free mercury in the vulcanized material may perhaps require a more extended series of experiments. It is the only agent that can possibly exert any deleterious action upon the system. That its presence is rare is proven; that it is never found can be confidently asserted or denied only after the extended observations recommended, the observers, however, being careful not to confound the minute crystals of sulphur with globules of mercury, as some have done.

Impressions for vulcanite work may be taken in plaster, wax, gutta-percha, or modeling composition. The minute accuracy of plaster is not so essential in swaged work, since the very fine lines of the model are partly lost in the die and could not be impressed on the plate; but in the vulcanite the faintest scratch is faithfully copied. The finest plaster must be used and stirred until all air bubbles are removed. Although fine plaster will give the minutest lines, yet many prefer for all laboratory use a moderately coarse plaster, which becomes hard and strong when it sets, and recommend in all cases admissible plaster to be mixed as thick as it will work well, as thin-mixed plaster expands more than the thick-mixed. The fracture of the teeth of a plaster model may be prevented by inserting small pieces of wire or brass pins in the impressions of such teeth before pouring the plaster. The absolute necessity of plaster impressions, in most partial cases where vulcanite is used, led the late Prof. Austen to devise the method, elsewhere described, of taking impressions with gutta-percha trays. The advantages of a partial plaster impression thus obtained are:

first, the exact shape of the outside of the teeth adjoining the space to be filled permits correct adjustment upon the model; secondly, the accurate shape of the inside of the molars and bicuspids, at the point where wax or modeling composition impressions drag, allows the stays or half-clasps to be closely fitted to the teeth. But it must be borne in mind that partial impressions in plaster and partial pieces in vulcanite demand for their success the utmost care and nicety of manipulation, a care which the result will fully reward. The absolute non-contraction of rubber may make wax, modeling composition, or gutta-percha in some cases a better impression-material for full sets than plaster; in fact, we recommend plaster less often for full vulcanite plates than for base plates of any other material; while in partial cases, for reasons just given, we prefer its most exclusive use.

Vulcanite models require no particular shaping except the extension of the back part an inch or more, so that the model itself may serve as one-half of the articulator. This not only saves time and plaster, but gives more accurate results, since there is no transfer of the teeth and wax plate to a new wax model. When the teeth are set in the wax plate the model is then separated with a saw from the back part and placed in the flask. In double sets the back part of one model is smoothed and the T-shaped groove cut and soaped or covered with tin foil; the extension of the other model is left rough, and when the articulating plates are made the models are set into their respective plates and the space at the back part filled with plaster. Partial models containing a number of teeth require no other antagonizer than a model made from a simple impression in wax of the lower teeth, which will fit the irregularities of the teeth of the upper model. Models for vulcanite may be coated with very dilute soluble glass (liquid silex), collodion, or tin foil. The late Prof. Austen, in 1858, sent his earliest experiments in rubber to Dr. Putnam, of New York, to be vulcanized. The Doctor wrote to know "what the varnish was which prevented the rubber from sticking." It was this soluble glass, used originally for the purpose of hardening the surface, to prevent injury from subsequent manipulations.

Antagonizing plates are made by molding a piece of gutta-percha over the model, kept very wet to prevent adhesions. The central part should be not less than one-eighth of an inch thick, to give stiffness to the plate; the rim on the edge should be the exact length of the teeth required and trimmed very carefully on the outside to give the proper fullness. The gutta-percha should be first worked into a ball, using from one to two sheets, according to the size of the mouth; then, pressing from the centre outward, the articulating rim is formed at the same time that the material is turned over the ridge. It is

quickly done, will not injure the most delicate ridge, and gives a plate as unyielding as any gold plate. In a lower set the rim may be stiffened with a piece of heavy iron or copper wire. In a full or nearly full upper set the impress of the lower teeth is to be received in a thin rim of wax set on the gutta-percha. In a double set the rims are trimmed till they touch uniformly, and then their relation marked by decided indentations across the line of contact. It is quite possible with these gutta-percha plates to take the articulation in every case with such absolute accuracy that no trial of the teeth is necessary, nor any grinding of the teeth upon inserting them in the mouth. Metallic articulating plates swaged for the case are much more troublesome and are no better. The usual method of making them of sheet gutta-percha, wax, or tin foil can never give one that full confidence in his articulation which enables him habitually to dispense with the trial of the piece after grinding. As vulcanite articulations are often taken, it would be as well simply to look at the mouth and guess at them.

The modeling composition is an excellent material for a base plate in securing the articulation. After being softened and adapted to the cast a roll of softened wax is placed upon the base plate over the alveolar ridge and shaped to the form of the arch. After being tried in the mouth and added to or trimmed off if too short or too long, the patient is directed to bite into the wax. To prevent securing too long or too short a bite, one or more small blocks of soft pine wood, about half an inch square and thicker than the required bite, may be attached to the base plate with melted wax and trimmed off until the necessary length is obtained. The wax rim is then applied over the block and the proper articulation secured. For an entire denture the articulating rims may be made of modeling composition.

Preparatory to the selection and grinding of teeth or blocks the thick articulating plates must be removed and the model covered with thin druggist's foil, and the space inside the ridge filled with a mass of soft wax pressed out until it meets the probable inside line of the teeth to be fitted ; this affords a much firmer support to the teeth during grinding than the usual practice of using the thin wax or gutta-percha matrix plate. The top and outside of the ridge are left covered with foil alone. When blocks like Fig. 1122 are to be ground, passing over the front of ridge and surmounted with a rubber band, it is essential that the block shall not quite touch the model at any point; this contact is prevented by placing between the foil plate and the model a strip of foil having four, six, or eight thicknesses, as may be desired. But when blocks such as Figs. 1123 and 1124 or teeth like Fig. 1121 are ground resting directly upon the gum, with no rubber

above or under the upper part of the gum, the tin foil is retained only during the process of grinding, so as to receive the paint used in accurate fitting of blocks; the foil is then removed and the plaster scraped, so as to slightly bed the front blocks or teeth in the natural gums. As the teeth are ground they should be attached to the wax mass with softened or melted wax.

In grinding the greatest care must be taken to make close joints; but the fitting of the base requires none of the accuracy demanded in fitting gold plates, except when the tooth is to be set directly upon the gum. It is, however, a mistake to suppose that a space of half an inch can with perfect impunity be left between the teeth and plate; for vulcanite has a slight shrinkage on cooling. Unlike the shrinkage of metal, which is irresistible, that of vulcanite is controlled by the matrix, so that it results in no change in the shape of the plate. This is proved by the closeness with which it is seen to adhere to the model on opening the matrix. But it takes place in the direction of the

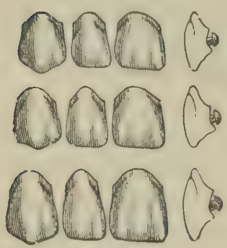


FIG. 1121.

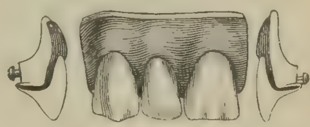


FIG. 1122.

FIG. 1123.

FIG. 1124.

thickness of the plate. If, therefore, a large bulk of material is interposed between the teeth and ridge, it will shrink perceptibly either from the ridge or from the teeth; in the first case impairing the fit of the piece, in the latter case loosening the hold of the rubber upon the tooth. Thick masses of vulcanite are also apt to be porous or honeycombed, owing to the evolution of sulphur. That sulphur is evolved in all cases is evident from the staining of the plaster, blackening of the flasks and inside of the vulcanizer, and from the peculiar smell whenever there is escape of steam. We sometimes find it makes the rubber porous, especially in lower cases, in spite of every precaution taken to prevent it. It is not impossible that subsequent modifications in the time and manner of vulcanizing may correct this and several other difficulties attendant on the hardening of thick masses of rubber; meanwhile it is safer to avoid all unnecessary thickness of material. Many cases will permit the use of a stout aluminium wire behind and under the pins, running along the incisors and bicuspids; if so, it will

reduce the bulk of rubber and strengthen the piece. We often run a heavy platinum wire or strip of doubled plate behind the entire arch in lower sets to add to their weight and strengthen them; when carefully done it makes a very strong piece, and removes the objection of lightness which prevents the use of rubber in many lower cases.

When the teeth or blocks are ground, and the joints and outside fitting carefully examined with a Coddington lens or some other strong magnifying glass, the next point is to make guiding grooves or holes in the plaster articulator below the teeth; then place the lead band and pour the temporary investing rim, as has been already described in the investment of teeth for gold plate preparatory to backing (see p. 921). If it is a partial piece we often prefer to make this rim with a roll of gutta-percha, previously wetting the model to prevent its adhesion. An elastic band or string will hold this rim in place while the wax is being removed and substituted by the matrix plate, that is, the wax plate which is to be replaced by the rubber. The use of the rim permits an examination of the blocks or teeth on the inner side and the correction of any irregularity in the pins or in the inner edge of porcelain where it meets the rubber, also the grinding off of any point where a block may come unnecessarily near the model.

A small roll of soft wax is then to be pressed against the pins and model, holding the rim firmly to prevent the slightest displacement of the blocks. A wax matrix plate is then slightly softened and pressed gently over the face of the model and the other wax up to the tooth. Be careful not to thin the wax unequally, and yet to press it into all the natural irregularities of the model and to bring out the tracings of the rugæ and the central raphé. If the first wax is trimmed so as to just clear the tips of the pins and have a slight curve where it joins the model, very little trimming of the wax plate will be necessary when blocks are used. This method also enables the operator to know exactly the thickness of the plate at all points. Gutta-percha does not answer so well as wax, as it cannot so readily be smoothed where it joins the blocks. After using the wax-knife around the edges it is well to go over the surface with a strip of oiled buckskin.

The wax plate should vary in thickness from No. 14 to No. 18 gauge plate (Fig. 921), according to the depth of the palatine arch. Vulcanite cannot safely be reduced to the thinness of gold or aluminium plates, or even of the best stannic alloys. The elasticity of the best made vulcanite is often thought to justify great thinness of plate, and this may be allowed in some partial pieces; but in full sets, or where many teeth lie grouped together, elasticity, with thinness such as permits bending of the plate, is very apt to cause opening of joints or breaking of blocks. Elasticity of vulcanite lessens the

chance of injury from an accidental fall; but as an element of strength it is principally valuable as improving its rigidity and toughness; and the plate of all full sets should be thick enough to be unyielding under the force of mastication.

Fig. 1125 represents Dr. R. Wünsches' perforated metal plate, by

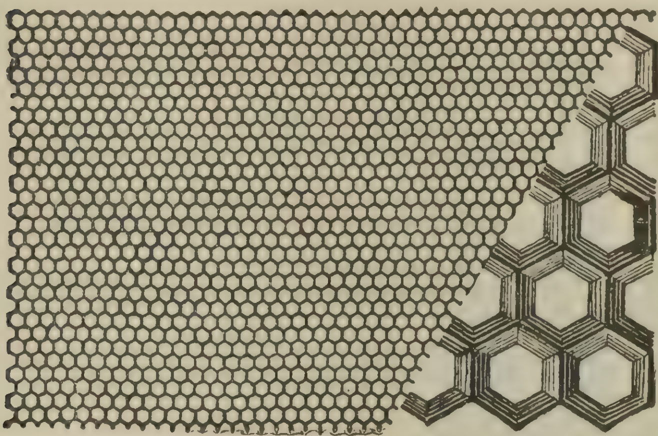


FIG. 1125.

the use of which, in combination with rubber, dental plates may be made much thinner than if made of rubber only. It is also claimed that these plates give additional strength; the holes in the plate are countersunk, forming a head or clinch on the face of the plate, and thus preventing any danger of detachment.

Fig. 1126 represents the ends of a suitable wax spatula or knife. In flowing wax with the heated spatula around the teeth, after they have been accurately arranged upon the model, care must be taken to keep the joints free of it; and the wax plate should be fashioned and smoothed with either the blowpipe flame, benzine applied on a piece of soft cloth, or by the repeated and careful application of the warm spatula.

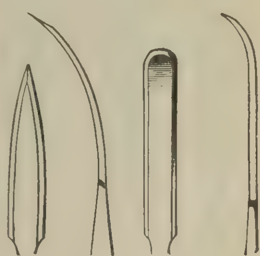


FIG. 1126.

The wax plate should be as perfect a counterpart of the vulcanite plate as it is possible to make it. Fig. 1127 represents a set of carving instruments, designed by Dr. W. W. Evans, for modeling wax in vulcanite, zylonite, and celluloid work.

When the inside wax plate has been completely finished the

outside plaster rim is removed, having provided for its easy removal by a break or section opposite the incisors. Again examine all joints with the glass to see that they have not been accidentally opened; then apply one or more strips of wax to give the required form of edge, outside the ridge and above the blocks. Plain or gum teeth or blocks, resting directly on the gum, must, of course, have no wax in front of incisors, canines, and first or even second bicuspids; in all such cases be careful, just before investing in the flask, to see that the teeth set closely down upon the model. Vulcanite blocks have a shoulder designed to receive the margin of the external rubber band; when the blocks have been chosen with such care that no grinding of the upper edge is necessary, this gives the best finish. But it often happens that the exigencies of the case require thinning or shortening of the blocks; a thin edge of wax should then slightly overlap the blocks. If the porcelain edge has sufficient thickness it is sometimes a good plan to bevel it; the rubber may then be finished continuously with the porcelain, and yet have a retaining edge. It is well to pass a very fine corundum slab over the gum just before placing the wax rim; it removes accidental roughness and makes the finishing process easier. Superfluous wax should be avoided outside as well as inside; but every undercut must be filled, else there will be danger of breaking thin or prominent ridges in separating the matrix. Outside surplus is more easily removed than inside; hence there is no objection to running the wax further up on the ridge than the finished plate; but unnecessary thickness is to be avoided for reasons before given.

FIG. 1127.

If the original model has been extended for articulation carefully remove the plate and saw off this portion of the model, and trim so as to fit the half flask in which it is to be set. This trimming done, replace the plate and fasten it around the edges with a hot wax-knife. It is now ready for the vulcanizing flask.

All forms of teeth may be used with the vulcanite base, and, unlike most other work, may be used again and again. Continuous-gum teeth can be strongly and handsomely arranged, provided the patient shows but little of the tooth; and also where celluloid is used in connection with vulcanite. Single teeth, plain or gum, require either to be backed with gold strips and soldered, or simply to have the pins lengthened. For this purpose heavy platina wire, say No. 20, should be cut into lengths from one-fourth to three fourths of an inch long, set between the pins in the required direction and soldered with pure gold. Plate teeth backed with a narrow platina strip, similar to Fig. 1128, may also be used, and are required in certain cases that will not admit of thick vulcanite teeth. The projecting tang strengthens the rubber in case of isolated teeth and may be serrated with a file; but a pair of

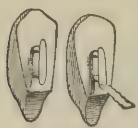


FIG. 1128.

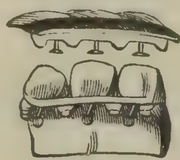


FIG. 1129.

forceps with serrated beaks may do this better and more quickly than the file. Occasionally some one or more under teeth strike so closely against the gum as almost to touch; if rubber is used in such cases these teeth must be plate teeth with the usual soldered gold backing, having a serrated extension into the rubber.

The assortment of vulcanite teeth now offered to the profession is, in variety of color, size, and shape, such as to meet almost every possible case. In fact, we doubt if the manufacturer's esthetic skill in making is not sometimes in advance of the dentist's esthetic taste in selecting. Certainly the stiff uniformity and monotonous expression which so frequently meet the eye is an injustice to the present high development of the dento-ceramic art. In the next chapter we shall illustrate by wood-cuts, kindly provided for us by the S. S. White Co., some of the delicate forms which so exactly imitate Nature. Figs. 1122, 1123, 1124, 1125, 1128, and 1129 will give a correct idea of the special form and shape of the ping of vulcanite teeth as at present manufactured.

Vulcanizers.—A sixteen-horse-power boiler, communicating by twenty feet of pipe with a thirty-inch cubical steam chest, was the vulcanizer of 1857.

The first one which was at all practicable as an office fixture was a two-chambered affair of cast iron, as large as a soda fountain reservoir, heated by a coal stove. Successive improvements have since been made, and the vulcanizer of to-day is a very different thing from the huge, clumsy affair from which it originated.

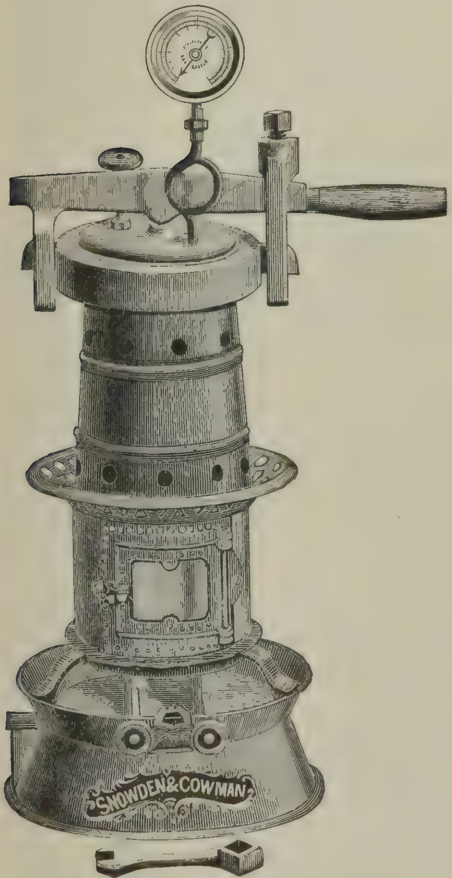


Fig. 1130.

The proper working of the vulcanizer and the satisfaction with which it is used depend, in a great measure, upon the perfection of the workmanship put upon it; and a saving of a dollar or two in first cost, coupled with the possession of a poorly-made machine, will prove an expensive investment in the long run.

Copper is now almost universally employed as the material from which the boiler or body of the vulcanizer is made, a ring of brass being brazed to the edge to form the packing joint and the attachment for the cover. The flexibility of these materials renders it important that the cover fastening should support the whole circumference of the edge of the boiler and bring the strain uniformly upon it in order to preserve the truth of the face of the packing joint. If the strain is brought to bear upon the circumference of the joint at intervals, the result is that the boiler gradually yields to the strains at the points where it is unsupported, the joint is drawn out of true, and in a short time the vulcanizer is leaky and comparatively worthless.

Figs. 1130, 1131, and 1132 represent the improved vulcanizers in use at the present time. Steam gauges are attached to the first two, and a thermometer to the other.

Fig. 1133 represents a dry steam vulcanizer for hardening vulcanite by dry steam, which, it is claimed, saves time and rubber, and gives to thin plates sufficient strength.

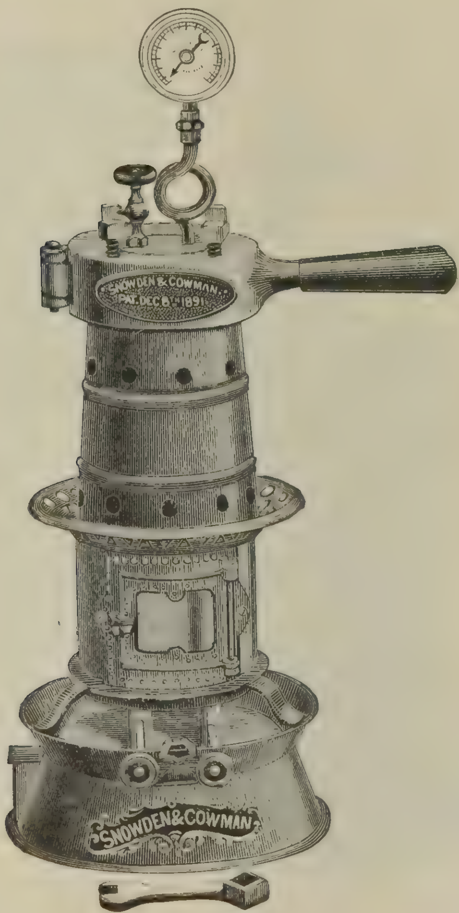


FIG. 1131.

The "New Mode Heater," Fig. 1134, invented by Dr. John S. Campbell, presents many points of difference when compared with other vulcanizers. It is made of phosphor-bronze, in a single casting, with two chambers, the one in which the flask is placed being surrounded by an outer steam-chamber. It has screws for closing the

flask as it is being heated, and is adapted to working celluloid as well as for vulcanizing rubber. Steam may be admitted to the vulcanizing chamber or not, as may be desired, and either "wet" or "dry" heat used. The use of the New Mode Heater, it is claimed, will prevent the rubber, when being vulcanized, from shrinking from the teeth, and also permit of the use of plain teeth with rubber for the base and celluloid for the gum, a form of work to which the name of "New

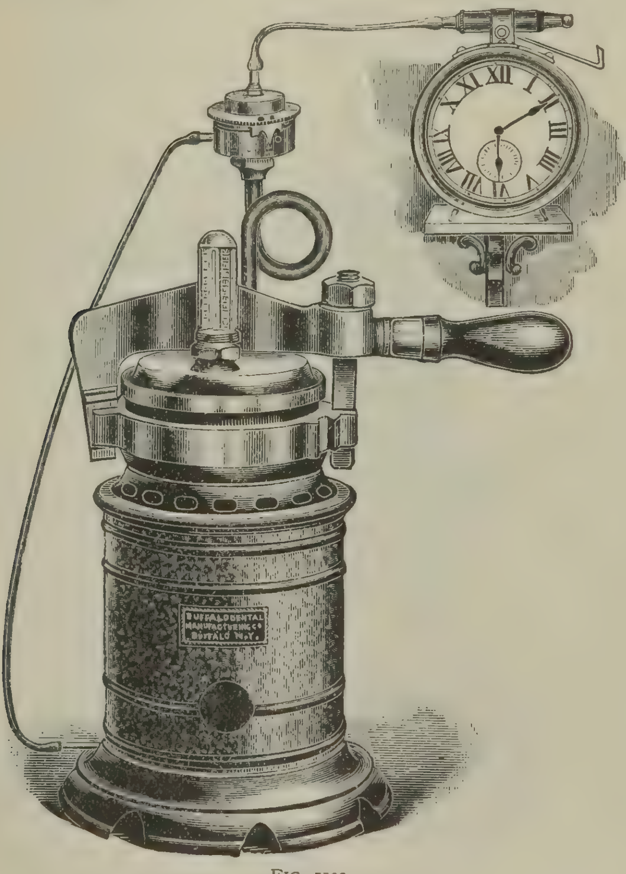


FIG. 1132.

Mode Continuous Gum" has been given by Dr. Campbell, the inventor (see Celluloid).

The vulcanizer is usually heated by either gas, alcohol, or kerosene. Gas, if used in a burner which will mix the proper quantity of air with it before burning is the most convenient, cleanest, and probably the cheapest fuel for the purpose. The flame should be a clear blue,

with no streaks of yellow. A yellow flame results from an insufficient mixture of air, and makes smoke, soot, and a bad smell from the production of acetylene. The use of gas also admits of the employment of the gas regulator (Fig. 1132), an attachment which automatically keeps the temperature of the vulcanizer at the exact point required. The steam pressure acts upon a valve to control the flow of gas to the burner, lessening the flow as the pressure rises and keeping it at the

FIG. 1133.

point for which it is set. It is not liable to get out of order and with it the supervision of the dentist over the vulcanizing process is not required; and if the time cut-off is also used the dentist is at liberty to go to his patients in the operating room without the necessity of giving a thought to the vulcanizer, knowing that the temperature will be kept exactly right and that the gas will be turned off at the right time. The results will thus be uniform; much more so than is possible

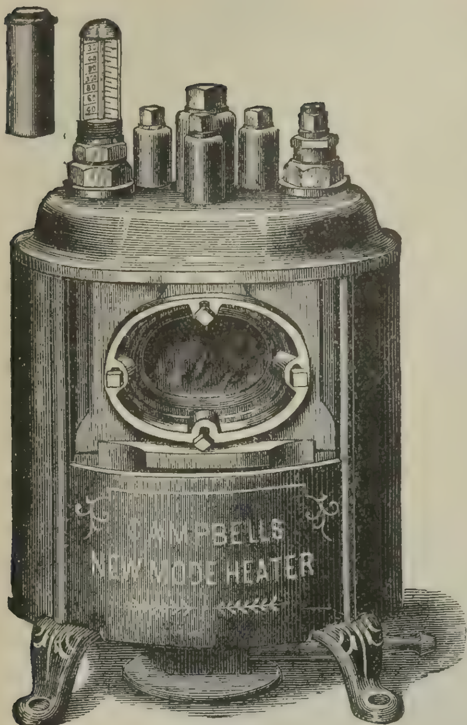


FIG. 1134.

with the use of the thermometer, as the regulator, operating by steam pressure, is more sensitive and exact than the thermometer can possibly be. After gas the alcohol flame is preferable for vulcanizing purposes. It is clean and inoffensive. Many use the kerosene stove, but taking into account its smoke and smell it may be doubted whether the economy secured by its use is not dearly bought.

The following tables, carefully collected from experiments of the French Academy, the Franklin Institute, Ure, Dalton, and others, will serve as a guide in the use of either the steam-guage or the mercurial thermometer:—

No. 1.					No. 2.	
Pressure per Square Inch.			Temperature.		Pounds.	Temperature.
Inches of Mercury.	Atmospheres.	Pounds Avoirdupois.	Scale Fahrenheit.	Differences.		
30	1	15	212°		63	300°
60	2	30	250°	38°	73	310°
90	3	45	275°	25°	80	315°
120	4	60	294°	19°	87	320°
150	5	75	309°	15°	95	325°
180	6	90	321°	12°	102	330°
210	7	105	332°	11°	110	335°
240	8	120	342°	10°	117	340°
270	9	135	352°	10°	124	345°
300	10	150	360°	8°	131	350°
360	12	180	374°	14°		
420	14	210	387°	13°		
480	16	240	398°	11°		
540	18	270	409°	11°		
600	20	300	419°	10°		
660	22	330	428°	9°		
720	24	360	436°	8°		

These tables show the increase of steam pressure with the temperature up to a point much higher than the dental vulcanizer should ever be called upon to bear. The second table is prepared especially to show the pressure due to the temperature at different vulcanizing points, and attention is especially called to the rapid increase of pressure with equal increments of heat as the temperature rises. The last column in Table No. 1 shows the additional temperature required for equal increments of pressure, and it will be seen that while it requires 38° to raise the pressure 15 pounds at 212°, only 4° is required for the same increase from 430°. The pressure nearly *doubles* with the addition of each 50° of heat, and allowing a vulcanizer to run up to 400° or 420° is shown to be a piece of unpardonable carelessness and a proceeding fraught with the greatest danger to life and property.

Every vulcanizer should be provided with some means by which the steam will be allowed to escape before the danger-point is reached. Safety-valves have been thoroughly tried and have proved unsatisfactory from their constant leakage. The fusible plug, consisting of an alloy of soft metal filling a hole in the vulcanizer, which would melt and blow out at 350° or 360°, was at one time much used, but it has the fatal defect of hardening after repeated heating, so that its melting point is raised to 400° or even more; so that after being used a short time it is wholly untrustworthy. A most satisfactory device for the purpose is the copper disc (Fig. 1135), made of metal thin enough to give way under an extreme pressure. It is secured upon the end of a small stud, screwed into the vulcanizer cap by means of a washer and screw-cap.

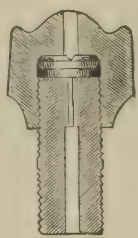


FIG. 1135.

Flasks.—Of flasks there are many varieties, made of iron and brass. The essentials of a good flask are: 1. It must have depth and width for the largest cases. 2. Both ends should be separate for greater convenience of placing the model in either ring. 3. The guide-fingers, about one-quarter of an inch long, should work straight and true, be strong, and yet not unnecessarily break the regularity of inside and outside surfaces; cover flanges may be very short. 4. Inside and outside should present as unbroken a surface as possible for facility in removing and cleaning off surplus plaster. Both rings should taper, partly to give greatest breadth to the line of junction, partly for easier delivery of plaster.

Figs. 1136 and 1137 represent the "Star" and "Anchor" flasks, the first being reversible; other flasks are also self-locking by means of flat springs on the outside of the lugs.

Fig. 1138 represents the "box flask," designed for extra large cases, splints for fractures, artificial palates, etc.

Making Matrix, Removing Wax, and Packing the Rubber.—The model of a full set is placed in the shallow half, A, of the flask (Fig. 1139), with wax plate and teeth attached, as before described. The model must be saturated with water, to prevent the too rapid setting of the plaster batter with which the flask is partly filled, and which, on placing the model, rises to the edge of flask and edge of the wax plate. The plaster should be mixed as thick as will pour readily and the lower section of the flask partly filled with it, when the model and

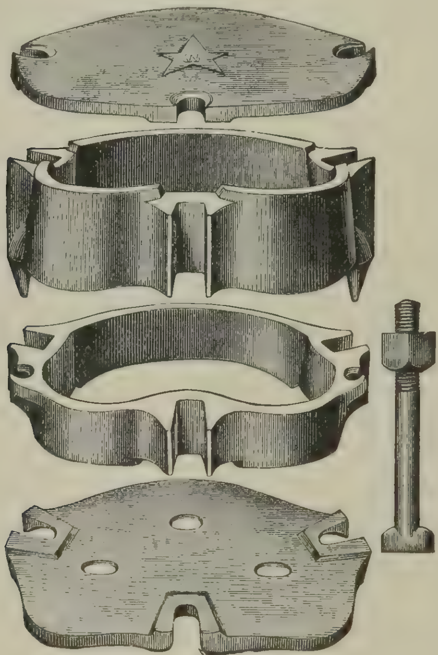


FIG. 1136.

teeth should be placed in it, bottom down, as shown in Fig. 1139, A, and slightly inclining in front so as to exclude all air bubbles when forcing it into place. In the case of an entire upper or lower set the plaster should extend up to the wax, as this will allow the teeth to be imbedded in the plaster filling the upper section of the flask. As soon as the plaster has become moderately firm trim smoothly up to the model with spatula or sponge; then soap this surface, or varnish and oil it, or cover it with tin foil. When shellac varnish is used, care should be taken that the teeth or gums are not coated with it.

Some prefer the soap solution, white soap, ℥j, soft water, Oj, for separating plaster surfaces. Some are in the habit of placing the lower

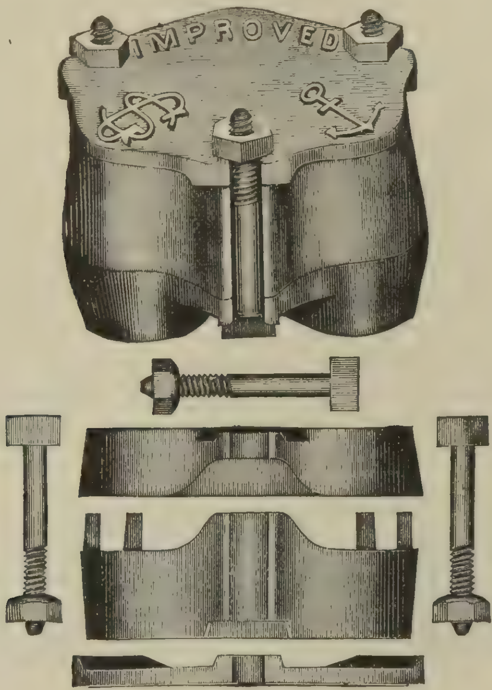


FIG. 1137.

FIG. 1138.

half of the flask in water, that it may absorb as much as possible before the upper half is poured. Mix a fresh lot of rather stiff batter, and brush it carefully over the wax and into all the interstices of the teeth. Then place the upper half-flask, C, accurately upon the lower half, and quickly pour the batter, stirring it well with a feather or small brush, into the space between the teeth and sides of the flask. Set on the cover D and apply the clamp B, or a heavy weight. Before it fully hardens wash off the plaster with a sponge from the outside of the flask, and let it get quite hard before separating the two halves. The object of making the batter stiff is to give it greater hardness for support of the blocks under pressure of packing. These are often displaced and the joints opened under moderate pressure; because, first, the batter is too thin, and, secondly, time is not allowed for it properly to harden before packing. The flask should be set in water at about 120° for five minutes before separation, so that in case of undercut or of a thin or prominent ridge there shall be no danger of breaking the model. Dry heat may also be used to separate the flask, but

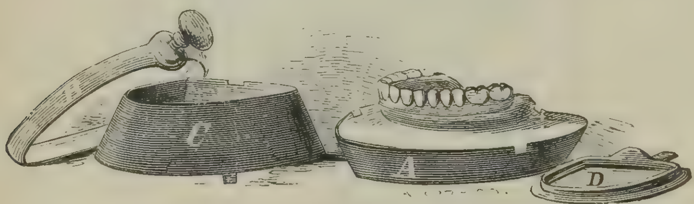


FIG. 1139.

the wet is preferable, as the former may melt the wax and cause it to be absorbed by the plaster; and if the base plate is gutta-percha it will, if made too hot, adhere to the model. The wax or gutta-percha model plate should be removed entire if possible, and also the wax around the pins, by means of a small excavator, and what remains may be washed away by pouring over the surface a stream of boiling water from a height of about one foot. All wax should be carefully removed in order to prevent deterioration of the rubber, and as much of it as possible be preserved for the purpose of determining the quantity of rubber necessary to use in packing the piece. After the wax is entirely removed vents or gates are cut in the plaster surface of the investments, as shown in Fig. 1143, to allow the excess of rubber to escape when the flask is closed. The flask will then present the appearance shown in Fig. 1140; the model-half, E, separating from the teeth and wax contained in the dental-half, H. Should the joints not be very closely fitted, place a little dry plaster over each and touch with a drop of water or diluted soluble glass, and when hard trim off

the surplus plaster. Some prefer to pack with tin or gold foil. The zinc cement in the form of the oxychlorid or oxyphosphate is also serviceable, and when used for such a purpose should be mixed quite thin and allowed to become as hard as possible. Without some such precaution the rubber will press into open joints and present an unsightly appearance; of course, closely-ground joints are preferable to any of these expedients; but neither the tightest joints nor any precautions will avail if strong pressure is used in packing, for this invariably opens the joints and admits the gum.

In partial cases, or where no vulcanite is required outside the arch and above the teeth (where plain teeth are used, resting directly upon the gum), the deep half, H, must be used for the model and the line of separation be made at the cutting-edges of the teeth, so that the plaster around the teeth may come nearly or quite level with the edge of the flask. The teeth are thus firmly fixed in their exact position and resist displacement, which the separation of the flasks or the pressure of the rubber might possibly occasion. In this way, should

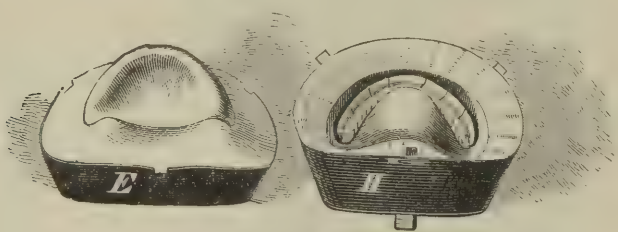


FIG. 1140.

the flasks chance not to come perfectly together, the result will be an extra thickness of plate, but no displacement of teeth. We consider this use of the deep-half of the flask in all partial cases as of the utmost importance. The teeth are never disturbed in their position on the model given them in the wax plate; also, there is no breaking of plaster teeth or splitting of the model by pressure of the rubber.

To prevent the rubber from adhering to the surface of the plaster model and mold, which gives a rough surface to the palatine portion of the plate, this surface, as before remarked, should be coated with either liquid silex, collodion, or tin foil. When liquid silex is used, a thin coat upon a moist plaster surface answers best; collodion is applied like liquid silex; tin foil is attached to the plaster surface by means of shellac varnish and carefully adapted by pressure with a soft cone of leather to all the inequalities, and its surface is coated with collodion, which is allowed to dry, when it is again coated with the soap solution. Such a method will render it easy to remove the tin

from the vulcanized rubber and give a polished surface. Without such precaution the use of muriatic acid may be necessary in order to remove the tin foil. Gilding the surface of the model with gold foil is also done.

Clean hands and instruments are very necessary in packing rubber, otherwise the color and even the texture of this material are impaired. The mold as well as the rubber should be warm during the packing process, and the latter should be cut in different sized pieces, using a large piece of the proper shape to cover the palatine surface of the model, and which may be applied by pressure with the thumb and fingers, first dipping them in water. Fig. 1141 represents a boiler suitable for heating the flasks, and having a flat top on which the rubber may be softened. In packing the smaller pieces of rubber,

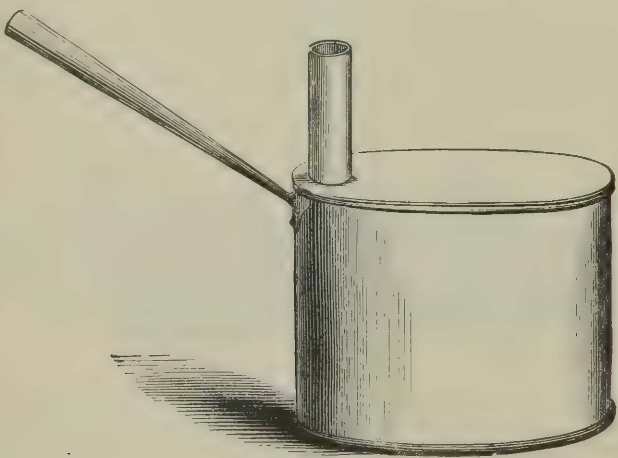


FIG. 1141.

and especially the long strips suitable for the rim of the plate, care is necessary that all particles of plaster be excluded, and also that too much rubber is not pressed against thin margins of the gum; otherwise fracture of the porcelain blocks may result when the flask is being closed. It is safer to pack the rubber thicker in the center, and as it yields to the pressure it will flow around weak points without danger of fracturing them. Each piece of rubber as it is added should be consolidated; and if any tooth or block has become loosened in the plaster a drop of liquid silex placed in the bottom of its plaster cavity will, after it becomes dry, hold it firmly in place.

It is desirable in all cases and quite essential in most that the flasks should come perfectly together. This is accomplished by attention to three points: 1. Softening the rubber; 2. Using a proper quan-

tity; 3. Having vents for the surplus. First, for softening the rubber use a deep, covered saucepan capable of holding the flask-press and containing two or three inches of water. When the flask is thoroughly heated by the steam, the rubber is placed over the cover of the saucepan or on a small shelf attached to the inside of the saucepan; then while soft let it be packed with the help of a pointed stick or the smooth end of a straight excavator flattened for the purpose into the dental half of the matrix. Around the teeth the rubber may be packed in the form of very narrow strips, somewhat as foil is inserted into the cavity of a tooth, with instruments made from excavators with blunt points bent at a right angle. The remainder is packed either in large strips or in one piece cut to the shape of the wax plate.

Secondly. It is important to use the proper quantity of rubber; too little vulcanite spoils the piece; too much requires a pressure which may break the blocks, displace the teeth, and force rubber into the joints, or else requires a long time for a safe degree of pressure to bring the flask together. In some cases the quantity can be correctly found by having the sheets of vulcanite exactly as thick as the wax plate, removing the latter as carefully as possible, and marking off its size on the former. But for some irregularly-shaped cases and most lower cases the following simple method will be found better. Let the plate be entirely of wax; remove it all from the matrix and roll it into a sheet the thickness of the rubber; make the rubber a little larger than the wax; then cut into conveniently-

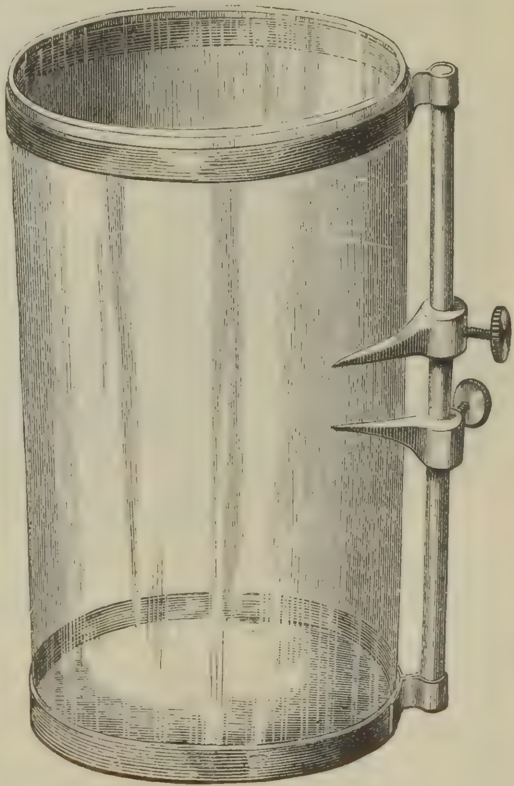


FIG. 1142.

sized strips and pack, putting most at those points where the wax was thickest. Starr's measuring glass, which determines the quantity of rubber by "displacement," is a convenient instrument for this purpose. (Fig. 1142.)

For ascertaining the quantity of rubber required for any given case: The vessel being about half filled with water, set the lower pointer to the level of the water; throw in every particle of the model plate; set the upper pointer to the rise of the water; empty the vessel and again fill with water to the lower pointer; add a sufficient quantity of rubber to cause the water to rise to the upper pointer and there will

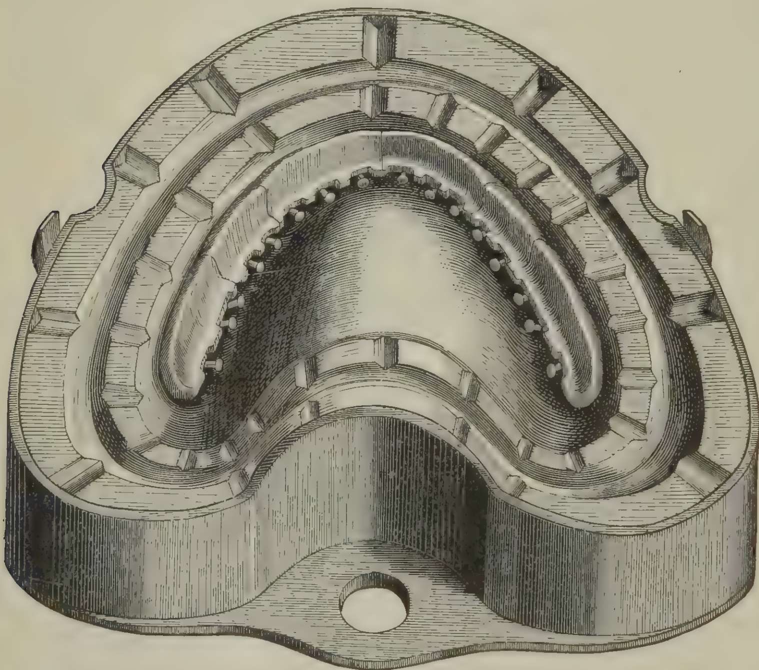


FIG. 1143.

be just enough to fill the mold. Allowance can then be made for surplus.

Thirdly. Since the error in quantity should always be on the safe side of excess, provision must be made for the escape of this surplus by cutting vents, that the halves of the matrix may come together without too great pressure. Fig. 1143, taken from Prof. Wildman's monograph, is a fine illustration of the best method of cutting these vents. The radiating vents might, however, stop at the circular groove, taking care to make this large enough for any possible excess

of rubber. If these leaders are too large next the plate the rubber may not pack so firmly as is desirable; also the generation of gas while vulcanizing may force rubber too freely into the groove, and so make it porous.

A good form of flask press is that of Messrs. Snowden and Cowman, Fig. 1144. As soon as the rubber is packed the halves of the flask are carefully brought together, placed in the press, and a moderate force applied; the press and flask are then placed in the heater. A piece of pure "rubber-packing," about an inch thick, placed under the screw, will, as before stated, insure a constantly acting force whilst in the heater. Avoid using the full power of even one hand

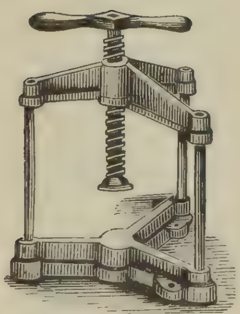


FIG. 1144.

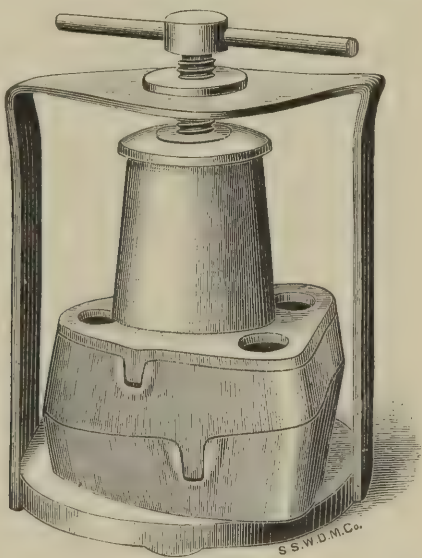


FIG. 1145.

upon the lever; if the vents are free and great excess of material is avoided, moderate pressure acting steadily in the heater will safely bring any flask together in from ten to forty minutes.

Fig. 1145 represents Dr. Donham's Spring Clamp, which utilizes the tension of a spring for closing the flasks in vulcanizing. It gives continuous pressure and dispenses with flask-bolts.

In all cases use a flask press first and the small screw bolts, except in the Donham clamp, when the case is ready for the vulcanizer. If pressure is applied suddenly, before the rubber is sufficiently plastic, there is great danger of fracturing the teeth, especially sectional blocks. When the screw bolts alone are used to bring the sections of the flask

together, no more pressure should be applied at first than can be made with the fingers, after which the flask is placed in boiling water for a few minutes, when a gentle turning of the screws will suffice to bring the parts together. Clean flasks are essential to successful packing, for soiled fingers stain the rubber, which interferes with perfect union of the pieces; hence all apparatus handled in packing should be so simple in form as to be readily cleaned; also, it is well to keep them constantly covered with a coating of varnish.

Dr. T. F. Chupein, referring to some valuable suggestions of Dr. Geo. B. Snow concerning the Physical Properties of Vulcanite, says: *—

"The writer, after giving many good points and making many valuable suggestions about vulcanite work and the behavior of vulcanite dental plates, recommends that when from the nature of the case it is found impracticable to make the plate of equal thickness, the places where the plate will be unduly thick be filled with small pieces of rubber which has been already vulcanized (an old rubber plate, for example, cut up and cleanly filed into small pieces about the size of duck-shot), to compensate for the undue thickness of the plate at these points and to control the expansion or contraction of the material.

"If a set of teeth be waxed up and flasked in the usual way, it will be extremely difficult to know where to place these pieces of vulcanized rubber; the memory being the only guide as to where they are to be put, the procedure is reduced to guesswork.

"To overcome this difficulty (recognizing the value of the suggestion) we proceed as follows: After the case has been waxed up as usual, whether gum section or plain teeth are used, the wax is carefully removed from the front part of the sections or from the front part of the plain teeth, so that these are held in place only by the wax on the palatal surface. Those parts of the sections or plain teeth and the plaster model are then painted with rubber solution (red rubber dissolved in chloroform), and when this dries small pieces of red rubber are packed next the sections to form the rim; or small pieces of pink rubber are packed next the plain teeth to form an imitation of the gum. This being done, the case is flasked so that the plaster of investment is brought all over the front part of the teeth as shown in the figure. Thus the small pieces of vulcanized rubber may be placed just where they are needed to compensate for the extra thickness or volume of rubber at these points.

"Fig. 1146 indicates the extent of such extra thickness under the

* Physical Properties of Vulcanite, *Dental Cosmos*, Aug. No., 1888.

bicuspids and molars, for which spaces the vulcanized pieces are to be prepared in the present instance.

"Incidentally it may be observed that by this mode of flasking the teeth are kept in their exact positions relatively to the cast, and, the gates being freely cut in the other part of the flask, the articulation will be found undisturbed even though the flask should not have been accurately and completely closed.

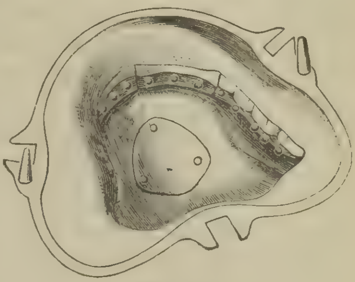


FIG. 1146.

"It is well to say that in removing the wax from the front part of the case this should be all removed before the case is painted with rubber solution, and the small pieces of red or pink vulcanite that are put in place of the wax that was removed should be added to the painted surface with a clean wax spatula, free from all grease, wax, or dirt, and heated (for easier manipulation of these pieces) in the blaze of a spirit-lamp. If there is any grease on the spatula the rubber will not stick to the places where it is wanted."

Time of Vulcanizing.—When the halves of the flask are brought into contact it is taken from the press, the screws are adjusted, and it is placed in the vulcanizer, which is then filled two-thirds full of boiling water, the cover adjusted, the gas or lamp lighted, and time reckoned from the moment of closing the cover.

The time occupied in heating up and vulcanizing varies with different varieties of rubber from fifteen minutes to an hour and a half. As thermometers vary much, and the rubber used also varies, the best plan is for every one to vulcanize trial pieces until the required hardness, toughness, and elasticity are obtained. It should curl under the scraper like horn, permit bending at an angle of at least 45°, and return to its original shape unchanged.

When the heat is too great, or the time too long, the rubber becomes dark and brittle. For the black rubber a longer time is necessary than for the red rubber, and the best method is to heat up very slowly unti it has reached 320° F., or to use a less heat and longer time. The more foreign matters rubber contains the less time is required to vulcanize it; and where the adulteration is considerable, as in the case of the pink rubber, the heat may be raised more rapidly, but such rubbers are weak and unfit for forming any more of the plate than the gum portion. In using the red rubbers the heat should not rise higher than 320°, and the piece should be allowed to stand until it is cold.

In a very large proportion of vulcanite pieces the full strength of the material is lost by overheating; in others by the opposite error of giving too much elasticity and throwing undue strain in full cases upon the blocks and the rim of rubber behind them. If some of the time spent in polishing up vulcanite and bringing out the offensively glaring brilliancy of its color were devoted to careful management of the vulcanizer, to making proper record of heatings, so as to arrive at uniform results, and to the cultivation of those habits of accuracy which alone can give success, there would be fewer broken pieces returned to the laboratory for repair.

Slow heating and a perfectly tight vulcanizer full of water, with flask well bound together and vents not too free, are the best safeguards against porous rubber, except where an unusual thickness is required, when the small pieces of hard vulcanite may be used in packing.

It sometimes happens, when large and thick masses are built upon the plate, as in cases of excessive absorption, that the thick portions of the plate, when vulcanized, prove to be soft and spongy in the center. This is the result, first, of bringing the plate up to the vulcanizing point too quickly and the retention of the sulphurous gas. A long time, even two, three, or four hours, the time depending upon the thickness of the mass of rubber to be hardened, should be taken to raise the temperature of the vulcanizer from, say 250° to 320°, if no pieces of hard rubber are used in packing. Second. Different samples of rubber act differently when vulcanized in thick masses, depending somewhat upon the amount of earthy matter contained in them. It is very difficult to vulcanize a mass of pure rubber and sulphur even three-eighths of an inch thick and insure its solidity. On the other hand, some of the English pink rubbers, which contain large amounts of oxid of zinc and vermilion, can be vulcanized in thick masses with but little trouble. It is to be remarked, also, that rubbers which are "loaded" with earthy matter have less shrinkage than those which are purer.

So the expedient may be resorted to of packing the inside of thick portions of the plate with some one of the rubbers containing more earthy matter than those usually employed, or using the same pieces of hard vulcanite as before described. The expedient of filling in parts of the mold where the thickness of rubber is excessive with a mixture of small fragments of old vulcanite and new rubber will answer every purpose as a safeguard against porosity. If the pieces are freshly filed all over their adhesion with the new material will be perfect, and the plate will be as strong as though wholly of new material.

There seems to be a point beyond which, if rubber twice passes,

it becomes inevitably brittle ; hence no confidence can be placed in the old material of a repaired piece. Two flasks in the same vulcanizer cannot give the same results ; loss of heat by radiation is greatest from the cover, and the supply of heat is from below ; hence, necessarily, the lower half of the oven is hotter than the upper. Uniformity of texture can be obtained, therefore, only by vulcanizing one piece at a time. One who is systematic in the arrangement of his work will separately vulcanize the pieces of a double set in very nearly the same time required if both are done at once ; for one piece may be in the oven while the other is in preparation for it.

Removal from Vulcanizer and Finishing.—Upon expiration of the time determined upon the flame is to be at once extinguished ; the vulcanizer may be cooled gradually as it stands, or rapidly by the escape of the steam, or by setting the lower three-fourths of the vulcanizer in cold water. The last method of rapid cooling is preferable, running the heat five minutes longer than when slow cooling is practiced. Letting off steam is a very disagreeable process and makes the plaster of the flasks very hard to cut out. Flasks may, with perfect safety, be cooled by setting the vulcanizer containing them in snow or pounded ice if desired ; but in no case should the flasks themselves be cooled by contact with cold water, as some might chance to penetrate to the blocks and crack them. The flask should be opened and the piece removed from its plaster investment within two or three hours after vulcanizing. After that time the plaster assumes a sand-like, granular state, and adheres with great tenacity to the plate, no matter what separating varnish may be used. Tapping the edges of the flask after separation will dislodge their contents in mass ; the plaster can then be trimmed from the piece, taking care that it is perfectly cold. The adherent plaster in the dental half of the flask can easily be washed from the piece with a stiff brush ; but the model half leaves a coating that clings very tenaciously, unless means are taken to prevent it ; soluble glass, a dilute ethereal solution of collodion, or a layer of thin foil have been already mentioned as the proper preventives.

The process of finishing is more troublesome than in the case of gold work, unless great care is used in the formation of the wax plate. Several sizes of round and half-round files are necessary for finishing up the edges and convex surfaces ; for the concave surfaces, scrapers, graving chisels, and curved files. Fig. 1147 represents common forms of rubber files.

Fig. 1148 represents several sizes of a form of scraper or finisher, suggested by Dr. Kingsley, with convex back and thin edges, which do not dull readily and are easily sharpened.

Lathe burs and file-cut wheels will be found very useful if there is to be much reduction of thickness—Figs. 1149 and 1150 represent one of each—the burs in sets of four and the wheels in sets of three.

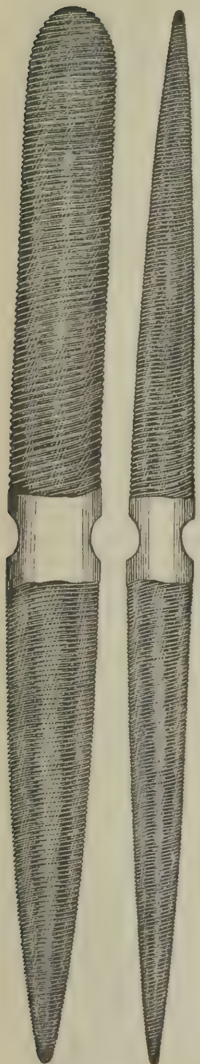


FIG. 1147.

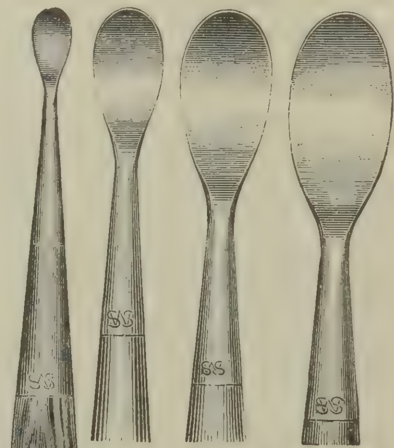


FIG. 1148.

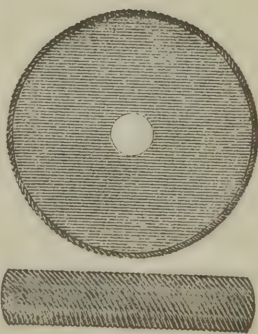


FIG. 1149.

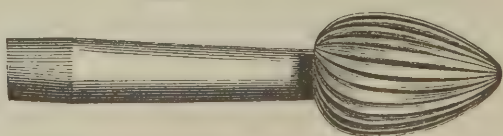


FIG. 1150.

Sufficient thickness must be left in the body of the plate for strength, but the edges should be chamfered off. A pair of calipers (Figs. 1109,

1110) are required to measure the thickness of the plate if it is to be reduced by files and scrapers, and the use of this instrument will lessen the danger of cutting through the plate. Some operators next use sand-paper or emery cloth; others use pumice stone on cork wheels; many prefer Scotch stone. The third step is the use of rotten stone (not Tripoli, which cuts with too keen a grit), either on a brush wheel with tallow or oil, which is the more rapid process, or on a stick of some hard wood, with water, which is the more cleanly. A little oxid of zinc on a soft wheel or on the finger will give a brilliant finishing polish, but is not essential, as the rotten stone can be made to polish very highly. After trying the piece and finding that no part of the edge requires alteration, a bright surface color may be given by placing the piece in alcohol and exposing to the sun's rays for six or twelve hours. Some regard this as an improvement; it certainly does not injure the quality of the plate, but the original mahogany color of the vulcanite is in much better taste than the bright vermilion tint thus given. In finishing partial cases it will prevent accident if, after filling the edges, plaster, or modeling composition, or gutta-percha is fitted to the palatine surface of the plate; the subsequent operations can be conducted more rapidly and with less danger in delicately shaped pieces. Vulcanite is softened by heat; hence a piece is sometimes bent by revolving the brush-wheel too rapidly. A piece that has been in any way bent or warped may be restored by heating either in boiling salt water or in oil to about 250°. While soft it may be bent with the fingers; but as this guess-work method is hazardous it is much better to bind it down upon a model and heat to the point of softening.

By pouring plaster upon the palatal surfaces of thin partial plates and allowing it to harden, the danger of changing the shape when polishing with a revolving wheel is avoided. To give a polished surface to a vulcanite plate and dispense with the usual finishing up and polishing process, the surface of the wax may be covered with tin foil, which is lightly but smoothly burnished to the surface of the wax. To insure a polished surface to the palatal surface of a vulcanite plate also the surface of the model may be varnished with shellac and then covered with tin foil, evenly applied; but a better method is to obtain a block tin or other suitable metal die from the plaster model and vulcanize upon it. When tin foil is applied to the surface of a wax plate all the wax may be removed without injury to the foil by pouring boiling water upon it. By the use of the improved heaters to vulcanize rubber, although a longer time is necessary than with the common vulcanizers, yet the strength and color of rubber so manipulated are improved. To vulcanize red rubber with these heaters the flask may

be heated and packed in the oven ; and when this process is completed the machine is closed, and the steam valve is then raised to admit the steam to the packing chamber. When the heat has been raised to 320° the case is allowed to remain in the hot box at that temperature for one and a half hours.

To produce a pure jet-black rubber plate, perfectly pure black rubber should be used, and vulcanized by the *dry* process. The model and investment should be thoroughly dried before packing the black rubber, and no steam be allowed to enter the packing chamber during the operation. The time required for vulcanizing black rubber by the *dry* process is five hours at 320°. To construct a vulcanized set with a celluloid gum, see chapter on Celluloid.

A modification of the vulcanite process was patented in 1868 by Dr. Stuck. Briefly described, it is the vulcanizing of rubber between two polished tin-foil plates, the articulating plate being formed upon a block-tin model made directly from the impression. The plate comes out highly polished, provided the tin foil has been carefully burnished into shape. On the palatine surface this polish is objectionable; hence we should prefer to vulcanize directly upon the block-tin model, the granulated surface of which is better for adhesion. The plate, thus made smaller than the mouth by the shrinkage of the tin, would in most cases fit better ; the difficulty is in removing the finished plate from the metal in case of a deep arch or slight undercut, an objection, however, which is now overcome by using shell or sectional tin models. A second peculiarity of Dr. Stuck's plates is their elasticity, compared with pieces as ordinarily prepared and vulcanized in the same oven. This, we suggest, is due to the retention of the sulphur by the foil plates on either side. We think these elastic plates are usually made too thin, under the idea that elasticity, like rigidity, compensates for diminished thickness. This method, though open to some objection, is worthy of careful investigation by every worker in vulcanite.

It sometimes happens that the rubber shrinks from the teeth, leaving a space in which particles of food and saliva collect. The cause of such shrinkage has been ascribed to the fact that the rubber in cooling from a temperature of 320° to that of the atmosphere, contracts more than any metal, and the plaster of the model and investment after boiling in sulphuretted-hydrogen water for sixty minutes is rendered very soft, and has not strength sufficient to hold the vulcanite in form while cooling ; but, on the contrary, yielding to pressure, allows the rubber to draw away from the teeth. It is claimed that any method which will prevent the plaster model and investment from becoming soft will overcome this objection.

Repairing and Refitting Plates.—Vulcanite work may be repaired by removing the broken tooth or block, cutting dovetails in the rubber, and then fitting the new teeth, arranging the wax, and vulcanizing as at first. To describe this method of repairing more in detail: if a tooth or block has been broken the fractured parts should be removed and a dovetail or groove formed in the base covering the space occupied by the tooth to be replaced. The tooth or block is then fitted by grinding and supported by wax, the dovetail being also filled up rather fuller than is necessary to restore the surface in order to allow for finishing. All of the set, except the portion of the lingual surface over the wax, is then imbedded in the lower half of the flask, and the plaster surface varnished and oiled to prevent adhesion when the upper section of the flask is adjusted and filled with the plaster investment. When the plaster has set and the two halves of the flask are separated, all of the wax is removed, the piece heated up, and rubber packed into the cavity around the tooth or block. The sections of the flask are then heated and screwed together and the process of vulcanizing completed. Another method of repairing rubber plates, and by which pressure is avoided, is to first cleanse the piece thoroughly, and to coat the inner surface with a little oil to prevent the plaster which is poured upon this surface in order to form a new model from adhering. When the plate is separated from the model dovetails are cut into the plate, and it is returned to the model and the teeth adjusted by grinding, after which the surface under them is coated with the rubber solder or liquid rubber, as are also such parts of the teeth and pins that are to come in contact with the rubber. The teeth being replaced, warm rubber is packed under them and into the dovetails, and the case is then invested in one mass of plaster, no flasks being used, and vulcanized in the ordinary manner. Where the plate is cracked or broken into two pieces the parts should be carefully adjusted and secured in place by either wax or ligatures and covered with plaster on its inner surface so as to form a model. The plate is removed from the plaster when it has set and a groove cut out the entire length of the crack or fracture, on either side of which dovetails are formed. When the pieces are returned to the model, the case is placed in the lower half of the flask and invested with plaster, all portions of the plate being covered except where the new rubber is to be packed. The rubber solder is then applied to the prepared surface and the rubber packed firmly into the groove and dovetails. The upper half of the flask is then adjusted and the investment completed, when the case is ready for vulcanizing. Instead of cutting dovetails, which are often disfiguring and sometimes impracticable, a liquid preparation may be used known as Rubber Solder. The surface of the old plate should

be brushed over with it just before packing. The adhesion is so perfect that the plate will break through old or new rubber sooner than separate. Before cutting out the old rubber the part of the plate under the broken teeth should be filled with plaster and then removed, so as to preserve the shape of the ridge; in case the process of repair requires that the plate shall be cut entirely through at this point, it is to be replaced before applying the wax. The second heating darkens the old rubber and makes it more brittle; full cases may admit of one, possibly two, such heatings. Partial cases should be repaired by replacing the entire plate with new rubber, although many repair as in full pieces. We decidedly prefer in both full and partial cases the entire replacement of the rubber. In doing this there are various ways of securing the correct relation of the teeth to the new model. To replace a broken partial or full plate, the teeth being uninjured, attach the broken parts firmly by resinous cement on the lingual surface; soap the rubber, or very slightly oil it, and make a new model; then surround it with a plaster rim, as explained on page 921, coming fully to the edges of the teeth. Remove the resinous cement from the lingual side of the plate and take a plaster copy of this surface and of the inside of the teeth, being careful in partial cases to slope the plaster so that it may be readily drawn. The plaster now enveloping the piece is in three or four parts; remove the plaster from the lingual surface; remove the rim in one or in two pieces; then carefully remove the plate from the model. Soften the rubber plate and remove the teeth; replace the plaster rim around the model and set the teeth or blocks in position, pressing a little wax under each to keep it in place. Now set model, rim, and teeth in the half-flask, first soaking in water to prevent too quick setting of the batter. Soap or cover with foil the plaster surface; then saturate and put in place the remaining lingual piece of plaster; set the other half-flask and pour the remaining half-matrix. Separate flask, pick out the pieces of wax; the case is then ready for packing and vulcanizing. By this process the new plate has the exact shape of the old one, and there is no necessity for molding a new wax plate. If the plate is of such form as to endanger the model in detaching, soften it by cautious use of the blowpipe flame.

If new teeth or block be required, let this be first fitted and wax properly shaped around it; then proceed as above. But if some modification in the shape or thickness of the plate is required, do not fill the lingual surface with plaster; but after making model and rim remove plate, reset teeth, adjust a new wax plate, and then proceed as in a new piece. If the vulcanite rim outside and above the teeth needs modification the plaster rim must be removed and wax placed there also, as in a new piece.

The black deposit which collects on vulcanite plates from long use, or from the smoke of tobacco, can be removed by applying a small quantity of a solution composed of aqua ammonia, alcohol, and chloroform, equal parts, and then adding pulverized pumice stone. After scouring with this mixture, the surface may be polished in the usual manner.

Dr. George B. Snow, in an excellent article on "Repairing Vulcanite Plates," gives the following suggestions:—

"It is not unusual to see vulcanite plates which have been cracked or broken, and repaired by what may be termed the 'hole and plaster' system. Holes are drilled through the plate along the edges of the crack, and a new thickness of rubber superimposed upon a mass which possibly is already too thick for comfort or convenience, the old crack still remaining as a weak point to occasion further breakage. No advantage was taken of any possibility of union between the old and new material, the dentist having been obviously ignorant of the fact that perfect union can be obtained in such cases if the surfaces of contact are freshly cut, absolutely clean, and properly roughened.

"The great point to be remembered in repairing or making any addition to a vulcanite plate is that the new and old material will unite perfectly, and with such firm adhesion that the plate will be practically as good as new if the surfaces of the old plate where union with the new material is desired are freshly filed, *absolutely clean*, properly roughened, and of sufficient area. To insure these results wax should not be melted upon the surfaces of union in waxing up, and removal of the wax from the mold should be accomplished by means of instruments and not by hot water, unless, possibly, for the removal of very small particles which cannot otherwise be got rid of. Any amount of the old material desired may be cut away and its place supplied by new, and thus any change wished may be effected. In case of breakage or cracking the plate should be cut away so that the old defects will be wholly obliterated and new material supplied.

"As a first instance, suppose a partial lower plate supplying the loss of the bicuspids and molars on both sides of the mouth to be broken through the bar which extends from one side of the mouth to the other behind the incisors. The fracture is generally a clean one, resembling that of glass or porcelain, and the two pieces may be brought into apposition with certainty. The dentist holding the parts together in exactly the right position, the assistant covers the lingual side of the plate at the point of fracture with a few drops of hot shellac from a shellac stick. A little cold water follows, and the two parts of the plate are firmly cemented together. A brace is now extended across from the molars on one side to those on the other by laying a burnt

match on the grinding surfaces of the respective teeth and fastening both ends with a few drops of hot wax. By this means sufficient strength is obtained to allow of the plate being safely handled. A piece of paper or sheet-wax is cut to fit and reach across the lingual space at the lower edge of the plate and fastened therein with wax, a coat of shellac varnish is applied to the paper, the surface lathered with soap-suds and rinsed, and a model run in the same manner as in filling an impression.

"After this has hardened the plate is removed from the model, which is then given a coating of liquid silex. This is always preferably done in repairing plates at the time when the plate is first removed from the model. The bar may be now wholly cut away close to the body of the plate on either side by a jeweler's saw, the cut being made diagonally so as to make what is termed a "scarf" joint. The surfaces should be further roughened by making a series of shallow parallel cuts across them with the saw, a thick separating file, or a thin-wheel engine bur. The parts of the plate are placed upon the model, waxed up, and flasked; the model and buccal surfaces of the teeth being covered with plaster, and the parting made so that the plate will be retained upon the model, while the pieces of the bar can be readily removed. After the flask is opened the pieces are removed, the usual gateways cut, and the packing, vulcanizing, and finishing done as usual.

"In the case of an entire lower set broken through the center, it will be seen that the same directions will apply, excepting as to the amount of rubber to be cut away. A free cut should be made on the lingual side, extending through under the teeth, to and including the labial band; so that the broken surfaces will be entirely obliterated and at least one-eighth inch in width of new rubber supplied between the cut surfaces. An engine-bur will do much of this work nicely, and a wheel-bur is very convenient for the purpose of scoring the surface. The making a model, flasking, and packing will be done as before.

"If one of the incisor-blocks be broken and needs replacement, a new one can be fitted after the model is obtained, and the remaining steps of the process followed as has been described.

"Upper plates are sometimes cracked in the center, the crack extending from under and between the incisor teeth backward over the palate. This often happens from the amount of rubber just behind the incisors being insufficient. It is not unusual to see it cut away at this point, so that the pins are almost or quite exposed, the plate having its usual thickness at a very short distance behind the teeth. A much larger amount of material will be tolerated here than is usually employed, and often with benefit, not only to the strength of the plate, but to the articulation of the wearer. The curve of the surface

of the plate should be made to resemble that of the palate before the removal of the teeth, and it will be found that the extra thickness may extend for half an inch behind the teeth without annoyance to the patient.

"A proper curvature to the surface of the plate just behind the incisors will do much to prevent the disagreeable whistling in making the *s* sound, and will assist in giving the correct enunciation to *sh*, *zh*, and other linguals.

"If the cracked plate fits a flat mouth a model can often be drawn from it as it is; but if the arch is high and the gums projecting it is better, after thoroughly cleaning and drying the plate, to finish the cracking by breaking the plate entirely in two. The two halves may now be fastened together by dropping shellac upon the lingual side, and a model secured from which either half of the plate can be easily removed. The whole palatal portion of the plate can then be removed by a saw-cut, leaving only a narrow margin on the lingual surface inside the teeth. The remainder of the surfaces of fracture are cut away as directed in case of the lower plate, the new surfaces roughened, the pieces of the old plate replaced upon the model (which has received its coating of liquid silex), waxed up, flasked, packed, and vulcanized, the teeth being retained upon the model as before described. The plate, when finished, will show the old rim and a margin of the old rubber inside the teeth.

"It is sometimes desirable to change the substance of the plate entirely, as in case of supposed mercurial poisoning by red rubber; or at least to put what red rubber there may be about the plate entirely out of sight and to reduce its quantity to a minimum. If this is to be done to the plate last under consideration, it should be prepared for flasking as described, excepting that the labial band should be cut away, and everything arranged so that the plate can be separated from the model when flasked. The parts cut away should, of course, be replaced by wax. The case is now set in the flask so as to leave the parting at the upper edges of the gums. The plaster is varnished and oiled and more plaster built on against the labial sides of the teeth, extending from their cutting-edges to the edge of the flask, and again varnished and oiled, so that the appearance will now be precisely similar to a plate flasked so as to be retained upon the model. The ring of the flask is now put in place and filled, and the plaster allowed to harden.

"When the flask is separated the teeth will be found in its ring-section. A few blows of the hammer will dislodge them, with the piece of plaster built against their labial surfaces. This is carefully broken away in two pieces if possible, which are preserved, and the teeth and

rubber encasing them is left. The rubber is now filed away as much as is practicable, leaving none of the old rubber in sight and removing enough from the palatal surface to make a new fit to the model. The teeth and plaster are replaced in the flask and the case is ready for packing and vulcanizing, and when finished none of the old rubber will be seen, and the plate will be practically as good as though the teeth had been removed from the old plate and reset.

"It is sometimes difficult to prevent the rubber from showing at the joint between the incisors; great care should be exercised in bringing the sections together properly and in holding them in position while flasking. If there is room a small wisp of loose cotton, not larger than a thread, may be tucked into the joint on its palatal side, the edges of the blocks being beveled to admit of this being done.

"It is evident that the change from red to black rubber just described can be made with a whole plate or a broken one indifferently. If a change of articulation and a new fit to the mouth is also desired on account of shrinkage of the gums, the plate should be prepared so as to draw from the model, and a few small pieces of wax put in the palatal side to bear upon the alveolar ridge, and give the right articulation by trial in the mouth, the center of the plate being cut away to facilitate the fitting of the plate to the model. A fresh model of the mouth being secured from an impression, the plate is waxed on to it, the case is flasked with a false piece of plaster built against the labial sides of the teeth as has been before described, and the plate afterward removed and cut away as much as desired, a considerable amount always being taken from its palatal surface.

"This process not only gives a new fit, but allows the material of the plate to be substantially changed. Holes and dovetails, it will be seen, are wholly unnecessary, and the fine serrated edge left by cross-cutting the surfaces of union will be found an excellent guide in scraping the plate to avoid overlaps. The use of shellac as a cement is strongly advised in repairing, as it is rigid and brittle when cold, and the broken parts, if once properly brought together, cannot get out of adjustment without at once attracting attention by the breakage of the cement. Wax does not answer the purpose nearly so well.

"The amount of shrinkage in vulcanite from cooling after vulcanization is not so generally noticed and provided for as it should be. Plates composed of single teeth do not give trouble from this cause, but full plates on which sections are mounted are often very vexatious to the dentist from the change of shape they undergo from shrinkage.

The reason of this is that the ends of the sections abutting form an

arch of porcelain, which expands or contracts but slightly from changes of temperature. The rib of vulcanite immediately inside this arch, and in which the pins are imbedded, forms a second arch closely attached by the pins to the first one. The plate is molded to the model and hardened at a temperature of about 320°, and is afterward placed in the mouth, where the temperature is in the neighborhood of 90°. Under these circumstances the contraction of the rubber which ensues has the effect of lessening the radius of the arch, drawing the heels of the plate together, thus rendering it a little too narrow to fit the mouth accurately. This has the further effect of elevating the palatal portion of the plate, which, when tried in the mouth, will usually be found to rock slightly, often so much as to interfere with its fitting.

"If the plate has been made upon a model taken from the mouth the difficulty is overcome by warming the back part of its palatal portion, pressing it down slightly, and cooling it while the pressure is continued, the narrowing of the plate being too small in amount to be itself objectionable.

"This change can be accomplished with more certainty by making a small plaster cast of the palatal portion of the plate, placing upon the part where the change is desired a small piece of folded paper, folded so as to present a thick center, and forcing the plate down upon it after its palatal portion has been warmed.

"The shrinkage here alluded to becomes a more serious matter when the plate is re-vulcanized in the course of repairing it. It is flasked when the change in form by its shrinkage has already once manifested itself, and again heated to 320°; and in cooling a second shrinkage takes place, it becomes still narrower, and its fit, already defective, is made perceptibly worse. It now often becomes a matter of necessity to bring it back to its proper shape before it can be worn with comfort. To provide for this a small dot should be made with a pointed instrument on each side of the plate immediately behind the molars, and a pair of dividers set to the distance between these points. After vulcanization the dividers can be applied to the marks, and they will indicate the amount of shrinkage the plate has experienced. Let the plate now be warmed just behind the incisors and in the mesial line by repeated short puffs of a blowpipe flame. This must be done carefully and the heat not allowed to extend over an area much exceeding half an inch in diameter. When the rubber is sufficiently softened the plate should be taken by the heels, a pull made upon it sufficiently forcible to expand the arch, and a stream of cold water applied. The dividers will at once show if the change made is sufficient.

"When the plate is now tried in the mouth it may be that the back edge will not touch the roof, and air will be admitted under the plate, in which case the back edge should be warmed and forced up to its proper position.

"The same remarks apply to full lower plates as well, which often are found to have lost their fit in a measure, after having been re-vulcanized. The process above detailed will suffice to restore them to their former fit and render them again comfortable to the wearer."

If the teeth are to be reset because of change from absorption, or because of some inaccuracy in the fit of the plate, it will perhaps be best, in most cases, to proceed just as for a new piece, grinding the joints again for any change of arrangement. Sometimes rejointing the blocks may be saved by bedding their cutting edges and cusps in a gutta-percha rim before detaching from the plate; this will permit their adjustment to the new wax plate in a continuous arch. Sometimes the old plate may with advantage be used as an impression cup by roughening the rubber and using a very thin layer of wax or plaster, whichever best suits the case. In making the model extend it backward, as before described under Articulation of Plastic Work. Before removing the piece complete the articulator, making the plaster cover the edges and crowns of the teeth one-eighth of an inch. By setting the blocks, when removed from the old plate, into their depressions on the articulator the exact relations of blocks to the model is preserved; also, if the plaster of the impression is made accidentally too thick the articulator may be slightly closed. The wax plate is arranged first on the outside; the half-articulator is then removed and the inner part of the plate shaped. The articulating portion is then cut off, the model set in the flask, and the process completed in the usual manner.

Gold, platina, or aluminium plates may also be re-fitted to suit a mouth changed by absorption. Perforate the plate with holes about size No. 22 (Fig. 921), countersunk on lingual side, regularly arranged and about half an inch apart. Fill the lingual surface between teeth with plaster; remove this when hard and make countersinks in it opposite each hole in the plate. Set the plate on model and fasten it with wax around the entire edge; then place in half flask as usual. Replace the countersunk pieces of plaster and pour second half matrix; this piece of plaster and the wax around the edge prevent the batter of the matrix from getting between plate and model. Separate flask, cut vents, put in a sheet of prepared rubber of proper size, press matrix together, and vulcanize. The impression may be taken in the usual cups or in the plate itself, and with either plaster or wax, as the case may require; if taken in the plate, cleanse this carefully after making the model. The adhesion of the rubber may be increased by cutting

the palatine surface of the metallic plate with a sharp graver; it should be carefully cleansed just before packing the rubber.

Dr. Richardson gives the following method of refitting gold or vulcanite plates with a new vulcanite lining: "Perforate the palatal portions of the plate with from eight to twelve holes at different points, and also the extreme borders, from heel to heel of the plate, at intervals of one-eighth to half an inch apart and near the edges. These holes may be enlarged to the dimensions of a medium-sized knitting-needle; or, if the piece is of vulcanite, to twice or three times that size. On the lingual and buccal surfaces the holes are well countersunk with a bur drill. The plate is employed as a cup or holder to take an impression of the mouth in plaster, being pressed up closely to the parts. The plaster forced through the holes, and filling the countersinks on the opposite side of the plate, will serve to bind the plaster to the plate and prevent the two from separating as they are detached from the mouth. When removed the plaster impression lining the plate is trimmed even with the borders of the latter and varnished and oiled. The lower section of the vulcanizing flask is now filled with a batter of plaster on a level with its upper surface, and the impression filled with the same is turned over and placed in the center of the flask, with the edges of the plate touching the surface of the plaster. The plate and adhering plaster are now carefully separated from the model. After cutting out the plaster from the holes and countersinks in the plate the plaster forming the impression is detached from the plate and the holes and countersinks filled with wax. The plate is then re-adjusted over the model and (the surrounding surface of the plaster in the flask having been varnished and oiled) plaster is poured in upon the upper surface of the plate and teeth, filling the upper ring. When the plaster is sufficiently hard the two sections of the flask are separated and grooves formed, running out from the matrix to the margins of the flask. A sufficient quantity of vulcanizable rubber is now either placed upon the model or packed in upon the palatal surface of the plate; before doing which, however, the wax filling the holes and countersinks in the plate (and which was placed there to prevent portions of plaster last poured, in forming the matrix, from filling them up) should be worked out with a small instrument. The whole being sufficiently heated, the two sections of the flask are forced together, expelling redundant material. The piece is then vulcanized."

The late Dr. Wildman suggested the following method of forming a new plate without changing the articulation of the teeth: "Roughen the palatal surface of the rubber plate to cause the plaster to adhere to it; then use it as an impression cup to take a plaster impression, being careful, when it is in the mouth, to preserve the articulation.

In this impression cast the model; trim and cut conical holes at several points in its outer face. Now, before separating the impression from the model, make a cast of the face of the teeth in two or three perpendicular sections, extending to the base of the model, using a solution of soap or other parting substance on the plaster model. Remove this mold of the face of the teeth, which indicates their true position relative to the model. Then take the impression from the model. By the aid of heat sufficient to soften the rubber remove the teeth from it. Next make a model plate with prepared gutta-percha, 'wax and paraffin (or modeling composition).' Now secure the sections of the mold of the face of the teeth to the model (their place will be indicated by the conical holes or keys); adjust the teeth in their proper positions in the plaster mold of them, and build up with wax to the proper form of the model set. This being done, test its accuracy of contour and articulation by placing it in the mouth. Then, using the model, proceed as for making a new set."

The method just described requires the presence of the patient; but cases occur where this is not possible, and owing to accident a new plate is necessary and the articulation must be preserved. Take a case, for an example, where the plate is so fractured that it cannot be repaired, and yet is capable of being temporarily adjusted by means of hot wax dropped from a spatula. When this is done the palatal surface of the plate is coated lightly with oil and plaster batter poured into it to form a model. Then trim the edges of the plate and sides of the model, and form holes of a conical shape to act as keys for the mold, which is made in sections of the outer face of the teeth. When this mold has become hard the sections of it are removed, as well as the plate from the plaster model. Undercuts may prevent the ready removal of the old vulcanite plate, and in such a case, to prevent injury to the model, the old plate should be softened by heat. The subsequent manipulation is the same as in the previous method.

When the plate is broken in half a rubber plate may be repaired by a method suggested by Dr. Gilbert: "Remove the denture, and with a fine Swiss saw cut away the palatal portion of the plate to within about an eighth of an inch of the inner surface of the teeth. In this remaining portion cut dovetails to retain the new rubber, and also form an undercut channel in the portion which fits over the alveolar ridge in the line of the break, as far as the edge of the rim; secure the parts to the model with wax. The cut-out palatal portion may then be laid back in place to aid in waxing up that part. Invest in the flask, covering the labial and grinding portions of the teeth, as in other repair work. After separating remove the part desired to be replaced with new material; pack and vulcanize as usual."

Partial pieces can usually be retained by stays and the fit of the plate. If clasps are called for these may be made of rubber alone if the clasps are short and the rubber elastic: or of rubber strengthened by a gold wire, which is to be curved around the clasp tooth just before packing. A gold clasp may also be fitted and retained in the rubber either by a projecting slip of the same metal or by soldering into it one or two platinum pins.

FIG. 1151.

Fig. 1151, taken from Prof. Wildman's monograph, represents these two forms of clasp; but in cases requiring clasps we very decidedly prefer a gold plate. The larger size of vulcanite plates necessary for strength will usually secure adhesion with the help of stays or half clasps; in none of these cases do we consider the vacuum cavity of any service.

Combination of Vulcanite and Metallic Plates.—Section or single plain and gum teeth may be secured to gold or aluminium plates by vulcanite instead of by soldering. Blocks having a porcelain gum on the inside, finished to the plate and having a countersunk base in which are platinum pins, present a very handsome appearance when attached to gold plate by vulcanite, and may be made very secure. The hole should be of good size, but must not come so near the translucent front of the tooth as to permit the color of the rubber to darken it. In this and the subsequent modes of attachment the swaging, articulation, and grinding of blocks is done as usual, except that there is less necessity for close fitting to the plate than in case of soldered work. The temporary plaster rim, elsewhere described, must in all cases be used, so as to permit removal and correct replacement of teeth. Where blocks or single teeth with holes in the base are to be supported by pins soldered to the plate, which is another mode of attachment, press each block into place over a thin layer of wax on the gold plate. The wax projection made by each hole shows where to drill the plate for the pins; then remove plate, drill holes, and solder roughened or headed pins into the plate opposite each hole; fasten the blocks temporarily with wax, then invest in the vulcanizing flask, so that on separating the matrix the plate shall come away in one half, the teeth in the other. Fill the holes with rubber and place a strip over the base of the blocks; warm and replace the two halves of the matrix, and vulcanize. Vulcanite blocks, such as those in Figs. 1152 and 1153, may be very firmly attached to metal plates by some one of the methods represented in Fig. 1154. Set the teeth or blocks in the temporary plaster rim and distinctly mark a line around the ridge, just under the head of the pins (C); mark across this line the position

of each pin (*a*, *b*, *c*, *d*); then remove blocks and prepare the plate for the different plans of retaining the vulcanite. 1st. For an aluminium plate which can have no soldered pins drill a row of small holes on the line between the pins; set it in the counter-die, and with a tapering punch enlarge each hole, with the projecting bur next

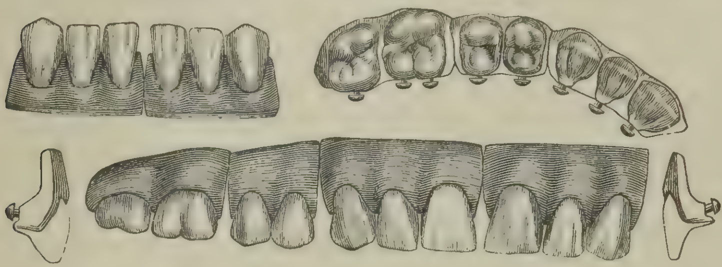


FIG. 1152. FIG. 1153.

the tooth (C, *c*). Let each hole be not smaller than No. 20 (Fig. 921). In some cases a smaller set of holes may be punched or drilled in the outer edge above the gum (C). Swage the plate again to correct the effect of this punching; then place it on model, replace blocks, arrange wax, and prepare for vulcanizing. 2d. Arrange the plate firmly on a piece of charcoal, set small cups of gold or platina on the line, between the pins (A, *a*), with a small piece of solder at each, and solder them all at one heating. 3d. Or drill small holes on the line, between the pins of the teeth (B, *b*), and insert headed platina or gold pins and solder them. 4th. Or drill two holes between the tooth-pins (E, *e*) and insert a loop; only one hole is really necessary, as the other end of the loop may be shortened so as just to touch the plate, to which the solder will attach it. 5th. Lastly, a wire may be bent in a series of waves (*d*), so as to pass under each tooth-pin (or just behind it if the pin is too close to the plate, but never over it) and rise from the plate between the pins. Adjust this wire accurately, with the blocks in place; mark the points of contact; then remove plate and solder the wire. The last four methods are applicable to gold and platinum, which admit of soldering. In soldering no plaster investment must be used, and the plate must have a good support on the charcoal; with these precautions careful soldering will not warp or spring the plate. If sprung

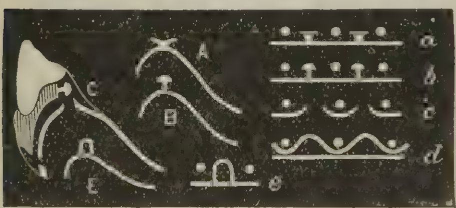


FIG. 1154.

the pins and loops make it necessary to cut a deep groove in the lead counter-die before attempting to swage.

After completing either of the five plans here described re-adjust the teeth in the plaster rim and fasten them in place with wax, trimmed to the shape required for the vulcanite; then invest in the flask and vulcanize as before described. By avoiding excess of rubber, using only so much as is necessary to conceal the pins or loops, the vulcanite band may have a very neat appearance. Some dentists partly conceal the rubber by an inside and outside band; but if concealment is necessary, we should prefer to do it by the form of blocks above given. If the inside band is used the simplest method is to mark the line of its position; then, by skillful use of the hammer, a strip of gold can be *paned* and with the pliers *bent* so as to have a uniform slope and a close fit; a file will be necessary over small prominences; this method of paning is simpler than either swaging a band or first making a lead or tin pattern. If cast plates of aluminium or other metal alloys are used it is only necessary to drill holes, as many, and of such size, as may be thought necessary, in that part of the plate next the blocks; they may pass through to the palatine surface if necessary and be countersunk. It is very important to ascertain, by trial, that the closely fitting edge of aluminium does not interfere with the teeth in separating and replacing the flask.

A method of attaching porcelain teeth to a metal base with vulcanite was devised by Dr. P. G. C. Hunt, and a process very similar was afterward introduced by Dr. Engle. It is described by Dr. Hunt as follows: "Thus far we proceed as we do for ordinary gold plate work. We will now suppose the teeth ground and jointed, leaving as much space between the teeth and plate as the plate will admit of. We next mark with a sharp-pointed instrument on the labial surface of the plate each point where it is necessary to place a loop for purposes hereinafter described; then apply wax to the external or labial parts of the teeth and plate, in any manner sufficient to retain the teeth in position; remove the wax from the lingual parts of the teeth and plate, and mark the position on the metal where it is desirable to insert the loops; remove the teeth and wax, and with a small bow-drill make holes through the plate at the several points previously determined on for the attachments about the size of an ordinary plate-punch hole; take a wire or ordinary gold plate cut in strips, say from a half to one line in width, being governed by the amount of room there is under the base of the teeth, and with small round-nosed pliers bend the strip around; grasp both ends with square-nosed pliers; draw the round-nosed pliers from the loop, still grasping the square-nosed pliers with the left hand, and with a hammer strike the top of the loop a sufficient

blow to keep the ends from springing apart; cut off the ends and dress down to fit the holes in the plate; after which solder on charcoal or other suitable substance without investment. Fig. 1155 illustrates the bent or hooked wire soldered to the base. Pickle, dress, and polish that portion of the plate to be exposed to view. Bend and flatten the pins; arrange the teeth, waxing so as to cover up the loops if practicable. The loops should be placed as near the base of the teeth as possible, the rubber forming, when finished, a part of the general concave shape which is desirable in upper dentures and which it is

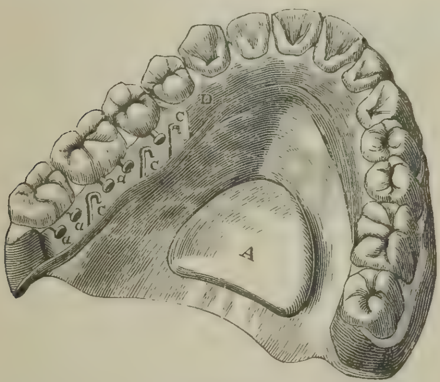


FIG. 1155.

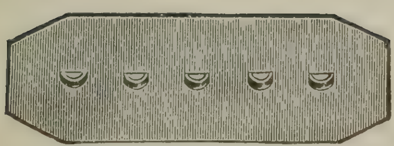


FIG. 1156.

not possible to obtain with ordinary soldered work. Then with silicate of soda paint the joints, to keep the rubber from forcing in where it would show after vulcanizing. Flask, vulcanize, and finish as usual.

A punch for forming loops in metal plates, and especially for aluminium plates, is represented by Fig. 1156. The size of the loop may be regulated by a thumbscrew.

Celluloid can be attached to a metal plate with the same loops and hooks by sawing out the palatal portion of the celluloid blank, and

trimming away as much of the remaining portion which covers the alveolar ridge as is necessary to avoid having an excess of material. When investing the piece the line of separation is made at the edge of the wax rim, thus permitting the plaster to cover the palatal portion of the metal. When the sections of the flask are separated the metal plate will occupy the lower and the teeth the upper portions.

The attachment of vulcanite to metal plates is an extremely useful and important application. It loses one of the peculiar advantages claimed for vulcanite, the accurate fit of the plate; but it makes very strong work, and is more cleanly than ordinary swaged work, because all interstices are completely closed. It also gives a shape behind the teeth more conformable to the natural shape of the teeth and gum. It obviates two of the principal objections urged against vulcanite—thickness of the plate and contact of the rubber against the gum and tongue. It dispenses with that accurate grinding of the base of blocks required in ordinary gold work, and obviates the risks of the soldering process. It is applicable to full sets, or to partial sets where the teeth are in groups of three or more. It is best repaired by removing the entire vulcanite attachment; but those who patch up old rubber plates can, with greater impunity, patch the "combination work;" since the strength of the piece depends mainly on the plate, the brittleness of second heating is of less moment. Another argument in its favor is that it makes available to gold-dentists the beautiful forms of rubber blocks, without identifying them with that class of rubber-dentists who, by accommodating the style of their work to the cheapness of the material, have brought much discredit upon dental mechanism. Dr. R. M. Chase has invented what he styles "a metallic-roof plate," which comprises a plate of gold or other metal to cover the roof of the mouth and a vulcanized extension attached to the edges of such a plate and extending over the alveolar ridge. The edge of the metallic plate is serrated or notched, and bent upward at an angle so that the vulcanite portion can be attached. In such a denture the metal portion only comes in contact with the roof of the mouth, while the vulcanite is restricted to the under and outer surfaces of the alveolar ridge. The method of constructing such a denture is described by Dr. Chase as follows: "Shape the plaster model so that it will easily drop from the sand by its own shape and weight by simply raising the flask at a right angle from the table. After shaping the model as described, mold wax and paraffin base-plate to the labial and buccal portion of the alveolar ridge of the model, filling all undercuts and irregularities, letting it extend over on to the alveolar ridge to the depth of from one-eighth to one-quarter of an inch. This should be beveled toward the palatine aspect, this being done with a view to

where the turned-up edge of the plate will not interfere with the pins of the teeth. The whole model, including the wax, should be shaped on a true bevel from the base to the beveled edge. Varnish the model, including the paraffin wax, with two or three coats of white shellac dissolved in alcohol. A model when prepared in this manner presents a beveled surface at all points, which makes sand-molding simplicity itself. When the shellac varnish is dry mold in fine sand. Do not pack the sand over the face of the model but a trifle, rather depend upon the weight of the sand to do this. Pack thoroughly around the side and top of the flask, so that when it is leveled off and reversed none will drop out.

"Having secured the impression of the model, melt zinc and make a die. When the die is cool reverse it and pack sand around it nearly as high as the top of the ridge, so that only the palatine surface and the beveled edge is exposed. Place over this a rim of iron about one inch larger in diameter than the die, and pour melted lead into the rim to the depth of one inch. Remove this counter-die and make another, but do not let the sand extend up higher than half an inch from the top of the ridge. The first counter serves to shape and partially swage upon. When this is done trim the edge of the plate where it bends over the edge of the die to the proper shape, not letting it extend beyond the top of the beveled edge. The second counter serves for the final swaging. It is seldom necessary to make more than one die and two counter-dies as described. When the plate is shaped upon the first counter, notch the turned-up edge about one-eighth of an inch apart, cutting into the metal to about one-thirty-second of an inch—where the turned-up edge commences or where it is to leave the cast, place back upon the die and smooth down the notched points, which will curl up in cutting. Anneal and place upon counter No. 2 and strike the die with two or three dead, pushing blows; this will finish the swaging process. Now saw or trim off the base of the model, remove the wax and paraffin, and adjust the trial-plate. Secure the bite or articulation; after this is done remove the trial-plate and fasten the metallic plate to the cast in position by a few drops of wax. Soften base plate, place this upon the labial and buccal surface of the cast, connecting it with the edge of the plate. Proceed to wax up the teeth in usual manner, letting the wax-backing extend on to the plate as far as desired when finished. When adjustment of the teeth and waxing process are completed, flask the same as for rubber, except the plaster should cover the metallic plate, extending a little above the edge or border of the wax. Soap the plaster, adjust the upper half of the flask, and fill with plaster. When hard, warm the flask and open. Remove all wax by pouring boiling hot water upon

it. Now, with a pair of narrow beak forceps, bend the notched parts every other one in opposite directions. This gives additional security against becoming detached when the extension is molded to it; vulcanize and finish." A vulcanized plate may be bleached by placing it in a glass vessel containing alcohol, and exposing to the sun's rays for from four to six hours; covering the top of the vessel with a plate of glass will prevent rapid evaporation. The pink rubber employed to give a more natural color to the gum requires to be bleached in order to render it sightly. To remove teeth from a vulcanite plate the piece may either be passed through an alcohol flame until the teeth become hot, or the set may be boiled in oil or imbedded in hot sand of such a temperature as will not char the plate. The latter method is preferable when care is taken to have the sand at a proper temperature, as the teeth or sectional blocks can be readily detached and all rubber adhering to the pins be removed by means of a pointed excavator. Any slight imperfections in a vulcanite plate in the form of a small hole left by plaster particles can be repaired by melting gum shellac and incorporating it with vulcanite filings. A cement thus formed can be introduced in a plastic state and made smooth with a heated spatula or burnisher.

Rubber can be made liquid for use as a rubber solder by cutting it into small pieces and dissolving by either benzine, turpentine, chloroform, ether, or bisulphid of carbon, all of these agents being solvents of rubber. The shape of a vulcanite plate can be changed by obtaining a correct impression and model of the mouth, upon which the plate, having been previously heated, is pressed by means of a napkin or piece of chamois skin, and held in position until it is cold. To soften the rubber plate the set may be immersed in boiling water, or placed in an oven with the teeth downward until the rubber becomes pliable; in the latter method care should be taken that the rubber is not blistered or charred. A more certain method, however, is to reconstruct the set.

For quick repair in the case of a broken tooth or sectional block a hard, quick-setting amalgam is sometimes employed, first cutting out a suitable cavity about the space to be filled, and after the tooth is properly adjusted packing the amalgam under it and about the pins, the tooth being firmly held in place during the operation. Wood's fusible metal has also been used for the same purpose and to close holes, the latter being countersunk on both surfaces and made oblong.

Spring plates consist of elastic partial pieces which are so constructed and vulcanized as to press against certain natural teeth, and thus be retained in position. After securing the model a little of the palatal surfaces of the plaster bicuspids and molars is scraped away, and in

forming the trial plate the wax is allowed to extend some distance from the necks of the retaining teeth upon the model, toward the grinding surfaces, in the form of partial stays. These plates are so shaped as to leave the central portion of the mouth free, no air-chambers or clasps being necessary. As the tendency of spring plates is to press the retaining teeth outward, they are not generally used. For mouths having soft places Dr. Land recommends an air-chamber covering four-fifths of the palatine arch and including certain parts of the alveolar walls (pages 973 and 974); and the same writer remarks: "To insure a comfortable adaptation the pressure must be so equalized that, as the alveolar ridge recedes, undue stress will not be brought on the palate. For this reason an air space, covering almost the entire surface of the palatine arch, is desirable, as thus the pressure is better distributed and brought to bear directly on the alveolar ridge, where there will be the least danger of injuring the mouth, thus avoiding the riding or rocking of the plate on the hard palate. The conventional air chamber, with its acute angles invariably placed on the most rigid portion of the hard palate, soon outlines itself in the tissues, demonstrating a failure to properly utilize atmospheric pressure and injuring the mouth by inducing absorption unnecessarily."

Dr. Hurd has suggested what he terms a "flange section" for lower plates, which is described as follows: An impression is first taken in wax, and this is used to obtain a plaster impression. The extreme projecting plaster at the sides of the tongue is cut off, and the surface varnished and filled up, so as to make a full model across from heel to heel, running far back upon the process, to keep the lip from pressing the plate back when the force of the muscles and lip is brought to bear upon it. After obtaining a correct articulation, a gutta-percha plate being used for the purpose, the teeth are set directly upon the center of the margin, perpendicular in front, but inclined at the sides, so as to allow for a sufficient space to form an outer flange for the lip to press down upon. This flange is then made by means of wax about one-third of an inch thick, with the inner surface rounded up in the same manner as the outside, but not made so thick and high, for the tongue to rest upon and keep down, thus excluding the air, the saliva which collects under the tongue also aiding in making the vacuum. It is necessary that the flange should rest gently against the cheek to give steadiness to the plate, and the teeth must be so arranged that they are level on the face. After vulcanizing, the piece is first cut away by filing at the hard margin on the under side of the outside flange, and increasing it near the edge of the plate at the cheek, and making a chamber. The inside of the plate is also cut away to free it from the sublingual muscles and glands, which tend to elevate the plate

when the tongue moves upward. In cases of malformation a thin, flexible rubber flange may be attached to the plate instead of the hard flange, so as to hold securely and conform to the movements of the muscles.

Lining Vulcanite Plates with Gold.—Vulcanite plates are sometimes covered with a gold lining on the palatine surface to prevent the contact of the rubber with the mucous membrane. What is known as the "vulcan gold lining" is composed of chemically pure gold, with a thin covering of pure silver. The flask is packed as usual and the gold is applied in one piece to the surface to be covered. The union between the rubber plate and the gold covering is mechanical; and the sulphur in the rubber when set free by the action of vulcanizing attacks the silver, sulphurizing the surface, and to this the rubber tightly adheres.

If the rubber plate is covered by the gold on both sides it is claimed that the vulcanite becomes tougher when vulcanized, for the reason that during this process the pressure against the metal gives the plate a surface more dense than it will have if vulcanized in contact with plaster. The sheets of this form of gold are of the thickness of No. 20 foil.

Vulcanite for Irregularity Appliances.—Of the peculiar adaptation of the vulcanite material to the correction of irregularity mention has been made in the chapter on that subject. No further special directions are required except on two points: first, to have the plaster which makes the model perfectly smooth and free from air bubbles; secondly, to coat the teeth before vulcanizing with soluble glass or collodion solution. Attention to these two points will give a plate which, if the impression is correct, will fit the teeth with most perfect accuracy.

Directions to Patient.—Upon the completion and insertion of a vulcanite piece the patient should be cautioned to cleanse it thoroughly at least once a day; also to keep it in water when not worn in the mouth. Extreme cleanliness is advisable in all kinds of artificial work, and many patients need no such direction; the special necessity for care in the case of vulcanite arises from the tenacity with which the mucous secretions adhere to the surface if from neglect they are allowed to collect upon it. This coating is most apt to collect at those points where the friction of the tongue and of the food does not remove it; the same care is necessary for its daily removal as is required to keep the natural teeth in good order. There is, however, this difference between cleanliness of the teeth and of the plate, that while both are essential to purity of the mouth, the secretions have no chemical action upon the plate, as they have upon the teeth.

One point affecting the durability of vulcanite plates has, perhaps, not been determined by a sufficient experience. It is well known that

silver and eighteen-carat gold undergo a change in the mouth which causes them to become more or less brittle; such is not the case with twenty-carat gold and with platinum. The change in these cases is partly the effect of mastication, acting as do the repeated blows of swaging; partly a galvanic action between the molecules of the alloyed metal. A similar but much more rapid change takes place in the gutta-percha which is used for impressions; also in the vulcanized gutta-percha and in all those preparations of vulcanized rubber with which foreign substances are largely mixed for the purpose of modifying the brown or red color. The brown rubber, being purer, will probably retain its toughness and elasticity longer than the red rubber. We have some specimen pieces of red rubber which seem, at the end of twelve years, to possess their original strength; and we know of one partial piece that has been worn constantly for ten years, which has never been repaired, and seems as strong as when first made. This point, however, requires the collected experience of many observers during a period of many years, carefully distinguishing between the brittleness of over-baking or twice vulcanizing, and that which may supervene as the result of certain molecular changes in the substance of the material. It is a change which, unlike the galvanic action in gold and silver plate, may not require the presence of the buccal fluids, but which will probably take place alike out of the mouth as in; for such is shown to be the case with gutta-percha.

CELLULOID.

Celluloid, like vulcanized rubber, a cheap base for artificial dentures, was first introduced in 1869, and during the existence of the "rubber patents" was much used by those who objected to become licensees of the Goodyear Rubber Company. The comparatively recent improvements made in the material, and methods of manipulating it, have commended celluloid to professional favor as a plastic substance more in harmony with the soft tissues of the mouth, as regards natural gum color, than rubber, although it is more liable than the latter substance to change form after molding and to absorb the oral secretions if not properly manipulated. Celluloid is obtained from cellulose, the woody fibre which constitutes the framework of plants, examples of which are furnished by hemp, linen, cotton-wool, etc. In the manufacture of celluloid the cellulose of hemp, which is the strongest, is first converted into paper by the usual method, its chemical properties during this process remaining unchanged. The hemp paper is then converted into pyroxylin (gun cotton), by immersing the paper in a strong mixture of nitric and sulphuric acids, afterward being thoroughly washed.

This process increases its weight about seventy per cent. and renders it highly explosive, taking fire at 300° Fahrenheit.

The pyroxylin is then reduced to a pulp, and a mixture made of the following ingredients: Pyroxylin, 100 parts; camphor, 40 parts; oxid of zinc, 2 parts; vermilion, 0.6 part. It will be seen, therefore, that celluloid is composed principally of pyroxylin, with camphor (dissolved in alcohol) as a solvent, and that it contains less vermilion than the red vulcanizable rubbers. After the ingredients are thoroughly mixed immense pressure is brought to bear upon the mass by means of a hydraulic press of two thousand pounds to the square inch, which squeezes the celluloid through a small orifice in the side, near the bottom of a strong cylinder. This pressure is necessary to condense and solidify the celluloid, which, as it presses out of the orifice in the cylinder, is cut into pieces and molded by heat and pressure into forms suitable for dental use, called "blanks," and which in size and shape approximate to the bases of upper and lower dentures. These "blanks" are then seasoned for some two months in a room kept at a temperature of 160° Fahrenheit, when they are ready for use. To manipulate a celluloid blank into a proper denture is by no means as easy an operation as the working of vulcanizable rubber, celluloid being a material that is liable to alteration in shape and character under different circumstances. Repeated failures are the result of manipulating celluloid like vulcanizable rubber; hence perfect molds, equal pressure, and metal dies are absolutely necessary for the usefulness and durability of such a denture. Experience proves that metal dies, which produce a surface proof against disintegration, are alone reliable. The coating of the surface of a wax and paraffin plate, and also of the plaster model, with tin foil, overcomes somewhat the difficulty of preventing the loss of too much of the camphor solvent by absorption, and obviates the necessity of removing the original surface possessed by a celluloid plate when it is taken from the heater.

In the preparation of a celluloid denture the manipulations are the same as for vulcanized rubber until the case is ready to invest in the flask. The plaster used for working celluloid should be of the best quality, and not mixed too thin. The pink paraffin and wax answers better than any other material for a base plate, a thin paraffin-and wax sheet being used for the plate, which is strengthened by adding to its surface either warmed paraffin or modeling composition, first covering the paraffin plate with No. 60 tin foil in order that the modeling composition may be removed without injuring the smooth surface of the thin paraffin base plate. The teeth are arranged upon the base plate and secured by dropping melted paraffin and wax around their roots A stick-form of paraffin and wax can be obtained, which

is very convenient, the method of using it being represented in Fig. 1157.

FIG. 1157.

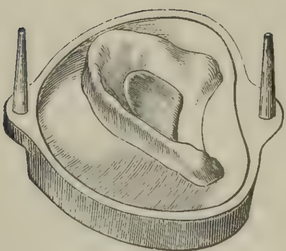


FIG. 1159.

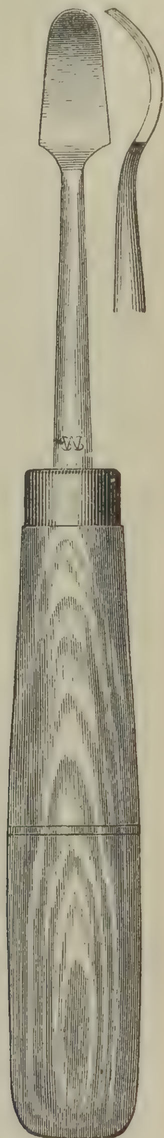


FIG. 1158.

The paraffin and wax compound is then carved into the shape of the gum desired by carving instruments, such as the set of Dr. W. W. Evans, represented in Fig. 1127; or a simple scraper may be used,

such as is represented in Fig. 1158. The surface of the paraffin and wax may be made very smooth by directing upon it the flame of an alcohol lamp with a blowpipe, care being taken to preserve the outlines of the carved gum. The more perfectly the wax is carved and smoothed, the less finishing of the surface of the celluloid will be necessary. The surface of the wax is then covered with heavy tin foil, which is burnished down lightly and smoothly.

The case is now ready for investing or flasking, after which the grooves are cut for excess of material; and in every case the parting of the flask should be at the edge of the wax, and the wax, teeth, and foil removed with the upper half of the flask, so that the surface of the model or cast is left clean and entirely exposed.

To prevent breaking a plaster cast, in cases of deep undercut, the method of investment suggested by the late Dr. Wildman should be followed. "It consists simply in so investing the cast that it shall occupy the position shown in Fig. 1159. If so placed, the pressure applied in molding is brought to bear upon the mass of plaster supporting the projection, instead of upon a thin section." Cutting away the base of the cast at the heel before investing it will elevate the anterior part in the manner referred to. After the sections of the flask are separated, the wax is removed by pouring boiling water upon it from the spout of a kettle, when the tin foil will remain upon the plaster surface. In some cases it may be necessary to cut away the thin edge of plaster which projects over the mold in the section of the flask containing the teeth. It is recommended to cut a groove for excess of material around the inside of the flask, about one-eighth of an inch from the model, and in this section of the flask, with no cross grooves connecting the main groove with the model, as is done in the case of vulcanite. All sharp edges of plaster liable to break off should be removed or rounded, and many prefer, especially when gum teeth are used, to cut away the plaster between the model and the edge of the flask all around, about the thirty-second of an inch, to allow the surplus celluloid to escape without pressing too much upon the gums of the teeth. In using a celluloid blank care should be taken to select one as near the size of the surface of the model as possible, for all folding, owing to too great width at the sides, will form creases in the plate; the blank may be reduced to a proper size by cutting down. Celluloid may be molded with steam, glycerin, or oil, and by dry heat, the latter giving the most perfect results. Fig. 1160 represents a sectional diagram of the steam molding apparatus of the Celluloid Manufacturing Company.

In using this steam apparatus the boiler is partly filled with water, the quantity being sufficient to cover the ribs at the bottom. The

screw is turned back so far that the plunger when in position is resting against the top of the boiler, so that the model may not be injured by pressure upon the flask while the cover is being screwed down. It is very necessary that the cover should be well turned down, the gland turned back, and the screw working easily, otherwise it is impossible to determine how much pressure is exerted; for if too much, the teeth or model may be broken, and if too little, the result is a porous plate. After the flask is placed in the apparatus the screw is turned down very gently with the thumb and finger, until it is felt to touch the flask. The heat, which may be generated with alcohol, kerosene, or gas, is then applied. The upper portion of the safety valve, which consists of two parts, may be suspended by the pins in the lead weight, and this valve should not allow the steam to escape at a temperature of 225° F. When the steam begins to blow off, strict attention is necessary, as the plate is readily

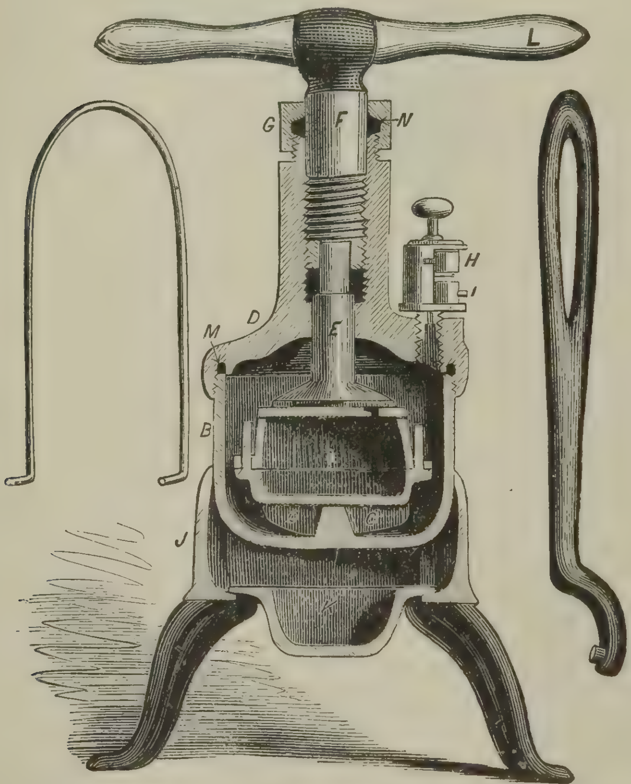


FIG. 1160.

injured by too much heat without the required pressure. The time necessary from this point, with the properly regulated heat, is from fifteen to twenty minutes. When the steam escapes from the valve, its upper portion being suspended, the plate begins to soften, and the screw is easily turned with the thumb and finger, when the upper weight should be dropped down. The screw is again turned very carefully, the pressure ceasing as soon as resistance is felt, and continued when it again yields. This careful screwing down is kept up, and the pressure somewhat increased as the steam rises, which can be determined by raising the valve, the object being to exert an equal pressure over the entire plate, before the steam blows off very sharply and continuously on raising the safety valve. At this point in the molding process the pressure should be increased, but an interval elapse between the turns of the screw in order to allow the celluloid, which flows very slowly, to escape under the pressure. At the end of the process, considerable pressure should be exerted by means of the screw, as much, indeed, as can be applied, or until the screw can no longer be turned. If alcohol is used to generate the heat, the cup of the apparatus is of such a size that its contents are consumed by the time the steam blows off from the safety valve, and the molding is completed. If gas or kerosene is employed, the flame should be so regulated as to complete the molding process within thirty to forty minutes, otherwise the celluloid may be injured.

To mold celluloid in glycerin or oil an apparatus represented by Fig. 1161 is employed. It consists of an open tank to contain the glycerin, with a thermometer to indicate the heat, a stand on detachable legs, and a screw-clamp to hold the flask. In the use of the glycerin apparatus, when the case is ready for molding, the celluloid blank is placed in the flask, which is then put in the screw-clamp, and the screw turned until it lightly presses upon the top of the flask. The whole case is then placed in the tank and sufficient glycerin poured in to cover the flask—about one and a half pounds.

The heat (which may be generated by alcohol, gas, or kerosene) is then applied, and as soon as its effect is felt by the screw yielding to slight pressure, about 225° F., the molding process is commenced. The screw should be very gently turned at first, and the pressure regulated by the softening of the celluloid, and increased as the flask closes. The flask in the clamp can be removed from the tank at times to note the progress of closing of the flask, which should take place evenly, so as to distribute the pressure equally over the entire plate. The heat should not rise above 280° F., and if the flask is not closed completely when this temperature is reached the flame may be reduced. Olive or lard oil may be used instead of glycerin, but the latter is

preferable on account of cleanliness. In using steam or glycerin, the flask should remain in the clamp until it has become cold; the cooling may be hastened by immersing the clamp and flask in cold water. Where the plate is of unusual thickness, or the blank is changed in shape to accommodate it to the case, it is recommended to place the flask, secured in a clamp, near a stove, at a temperature not exceeding 140° F., for at least half a day, in order to avoid the danger of warping the plate. It is also necessary, in the use of the steam apparatus, to put sufficient water in the heater, as too small a quantity may be entirely converted into steam, which is liable to become overheated, a result which is not only dangerous, but injurious to the celluloid.

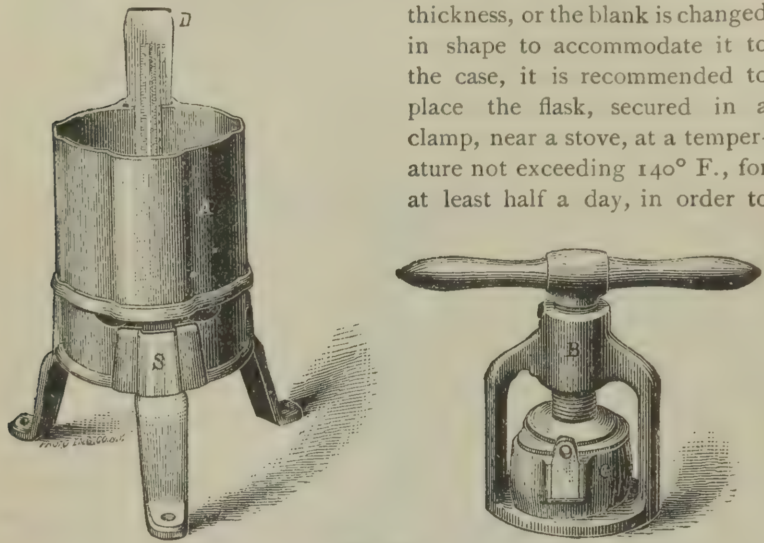


FIG. 1161.

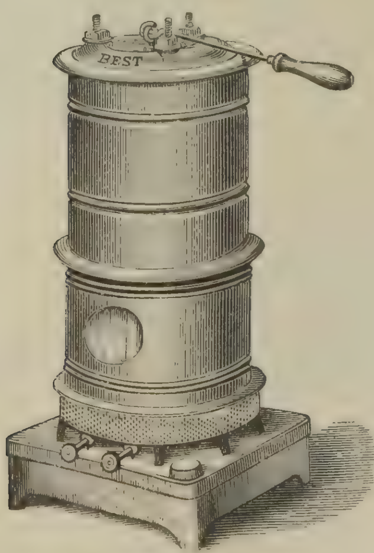
In molding celluloid by means of hot, moist air, several forms of apparatus may be used, one of the most prominent of which is the "Best" Hot Moist Air Celluloid Apparatus, represented in Fig. 1162.

In using the "Best" apparatus, the plaster in the flask should be made very wet by placing it in a flask of water before it is put into the heater. After this is done the flask is placed in the clamp, the top of which is screwed down until it comes in contact with the flask. It is then placed in the oven of the heater and the heat applied, the degree of which is determined by moistening the end of the finger and applying it to the flask. When it fizzles on contact, as a sad-iron does to the finger of a washerwoman, the flask is screwed together.

The point of a knife inserted between the edges of the flask will also determine the condition of the celluloid at this stage; also by experience in screwing down the flask. More pressure is applied as the celluloid softens or flows, allowing some little time to elapse

between the turning of the screws, until the sections of the flask are brought together, when the heat is removed in order to avoid injur-

RIGGED FOR GAS.



RIGGED FOR KEROSENE.

FIG. 1162.

ing the plate by making it porous. In the use of this apparatus the edges of the flask must not be pressed together until the celluloid is sufficiently softened to flow; and, on the other hand, the sections of the flask must not be kept apart too long or the plate will become hard from the evaporation of the camphor and obstruct the proper closing. The case is then removed from the oven of the heater and allowed to cool gradually, until it becomes quite cold.

For molding celluloid by dry heat, which is now considered to be preferable to either steam or glycerin, the New Mode Heater, represented by Fig. 1163, was the first apparatus invented which possessed superior advantages over the others used for the purpose, and also for vulcanizing rubber. It is a cylindrical-cast vessel, having two chambers, one within the other, the inner one being supported by piers or columns connecting its sides, top, and bottom with those of the outer chamber, the whole being made in one casting. The outer compartment is the steam-chamber or boiler, and incloses the hot-air or packing-chamber on all sides except the front, where the walls of the two chambers converge and become one, for the purpose of permitting access to the packing chamber. A door, made of the same metal as the boiler, and fitted with lead packing to make it steam-tight, is held in place by a bridge secured with screws. The door is also provided with a plate-glass light (shown in cut), through which the operator can watch the progress of the molding in the oven. The only communication between the two chambers is by means of a valve having its seat in the top of the packing-chamber, and controlled by a hollow stem which passes through the top of the machine.

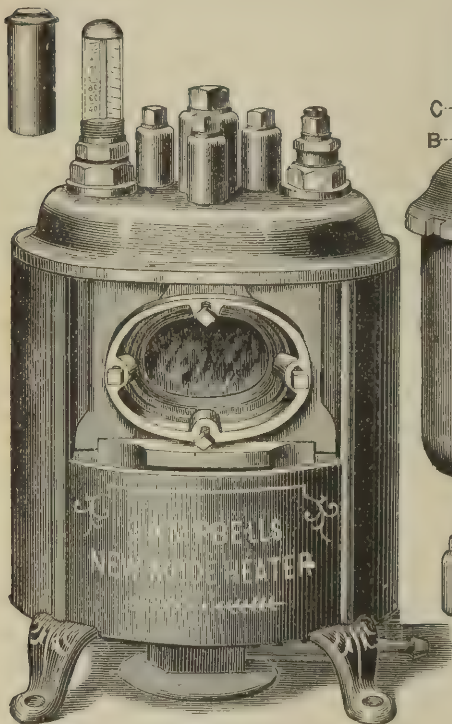
B is a mercury bath; C, thermometer; D, screw plug; E, lamnut; F, stem of steam-valve; G, screw-cap; H, large screw for closing the flask; I, I, I, smaller screws for the same purpose; K, K, K, L, nickle-plated caps for screws; O, O, steam-chamber.

The New Mode Heater, Seabury's and Evans's Vulcanizers (Fig. 1163) combine in one apparatus important improvements in the means of working both celluloid and rubber, that cannot fail to commend them to the favor of the profession.

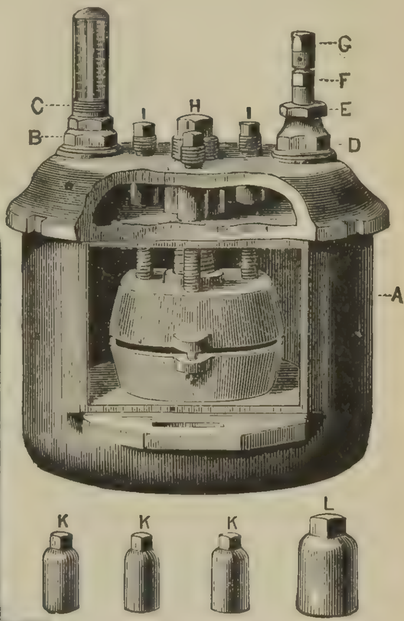
It is the conviction of the inventors, which is sustained by the experience of many experts in the use of both substances, that *perfect* work in either can only be made in a dry chamber, and that where a high degree of heat is used, such as is absolutely essential in the manipulation of celluloid, the temperature must be kept uniform until the work is complete, and must not be allowed to change suddenly.

Steam is used in these machines to heat up the packing-chamber and investment, but the chamber itself can be, and for certain kinds of work must be, kept absolutely dry after the molding commences,

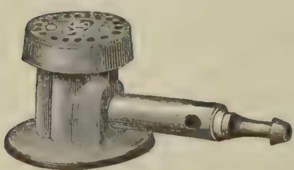
while the complete control which the operator has over the workings of the machine enables him to maintain the heat at any desired temperature. The hot-box or packing-chamber is nearly, in one, and in the others quite, surrounded by the boiler, and steam may be admitted to



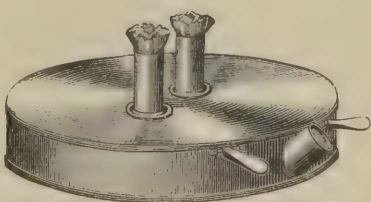
RIGGED FOR GAS.
Can be adapted for alcohol by substituting the lamp for the gas burner.



SECTIONAL VIEW.



GAS BURNER.



ALCOHOL LAMP.

FIG. 1163.

or excluded from the packing-chamber at will. A case may be removed from the heater and another one inserted without reducing the temperature or letting off the steam from the boiler, thus accomplishing a large saving of time. The boiler has no steam-packed plunger or screw

to cause uncertainty as to the amount of pressure applied. The top of the boiler, in the case of the New Mode Heater, is cast in one piece with the boiler; the flask is closed with a small key-wrench by the thumb and finger, the screw-bolts for closing the flask passing through the steam chamber in piers or columns; a steam-tight plate-glass door permits the operator to examine the work at any time during the process of molding, enabling him to apply the proper pressure at the right time, thus reducing the liability to break the cast, investment, or teeth. The descriptions of the Seabury and Evans machines, in the article on Vulcanite, will explain their manipulation.

Dry heat has no injurious effect on the celluloid material. If a piece of transparent celluloid be passed through a jet of steam, the transparency will disappear in an instant, and the material will become opaque and lose its hardness. A piece of the same transparent celluloid heated in a dry chamber to the same temperature as that of the jet of steam is not affected, its transparency and hardness remaining unchanged. So, too, a piece of black rubber vulcanized by dry heat is of a pure jet-black color when taken out; while a piece of the same black rubber vulcanized in the ordinary method shows brownish discolorations. These simple experiments show conclusively that the action of the steam is the cause of the loss of quality. Dr. Campbell gives the following directions for the molding of celluloid in his apparatus, which are also applicable to the others:—

To secure the best practical results, celluloid should be molded or pressed into the form desired at the highest possible temperature which will not burn it. To prove this it is only necessary to mold a plate on a metal cast at the lowest temperature at which it can be done, which is less than 212°, and another on the same cast at the highest temperature possible, say 310° or 320°, and lay the two aside for a few days, when it will be found that the one molded at the lower temperature will not fit the cast, while that molded at the higher temperature will fit as well as when first made. The reason is that the low temperature fails to overcome the tendency of the plate to return to its original form, while the high temperature renders it so thoroughly plastic that this tendency is entirely eradicated. This is proportionally the case with pieces made at intermediate temperatures; the higher the temperature to which the plate is subjected in molding, the more exactly will it hold its new form and the less will be its tendency to warp.

Celluloid may be readily and safely manipulated in the New Mode Heater at 320°, a temperature many degrees higher than is deemed safe in other machines, and which accomplishes perfectly the result above noted, and produces a plate which is believed to be absolutely

unchangeable in color, form, and texture. When this very high temperature is employed the celluloid should be in the machine only long enough to permit the closing of the flask; for the reason that heat vaporizes the camphor—the solvent of the material. If too much of this is driven off before the flask is closed it will be almost impossible to mold the blank to the desired form. The sooner the flask is closed after being placed in the oven the more readily it will be done and the better will be the result.

The molded surface of a piece of celluloid is much more durable than its interior, and will retain the color better. It is obvious, therefore, that this surface is essential to the integrity of the plate and should be preserved intact. To insure this, the case should be so prepared that the plate, when taken from the flask, will require little or no labor to make it ready for use. It is possible that some surplus material at the edges may have to be trimmed off and the edges smoothed, but the case is not properly prepared if more than this is necessary. The care and trouble involved in proper preparation will really save time, will absolutely avoid interference with the fit by the too free use of files, sand-paper, pumice, etc., and will insure a durable plate with a permanent imitation of gum-color. Moreover, the artistic taste of the operator may be exercised before the plate is molded more readily than afterward.

Paraffin and wax compound is used for the base plate, according to directions before given, and the teeth arranged, the wax carved into the shape desired by means of carving tools, and made smooth. The piece is then invested in plaster, the usual grooves cut, the wax teeth and tin foil being removed with the upper half of the flask in parting. The wax is then removed by means of boiling water, as before described, the tin foil, No. 60, used for covering the paraffin and wax plate remaining upon the plaster, and the investment is now ready to be dried out preparatory to receiving the celluloid.

Drying the Cast and Investment.—To dry a plaster cast and investment, and keep them free from cracks and checks, is very difficult by the ordinary means, but with the New Mode Heater it can be done so perfectly as to permit their use in casting pure gold or gold alloys.

There are two ways of drying the investment in the New Mode Heater: first, by raising the temperature to 320°, keeping the hot box dry; second, by admitting steam to the hot box. The former method can be used when the investment is placed in the chamber before getting up steam. If steam is up, however, either method may be employed. In using the dry heat method, open very slightly the screw cap of the piston or valve stem, to permit the escape of the steam generated from the water in the plaster, being careful that the steam

valve is firmly seated, as otherwise all the steam made in the boiler will escape. In using steam for drying, admit the live steam into the chamber with the investment by raising the valve from its seat, keeping the screw cap closed. The steam quickly permeates the plaster, and in five or ten minutes the temperature of the plaster is high enough to convert the water in it into steam. As soon as the plaster is thoroughly heated, shut off the steam by closing the valve, and raise the screw cap very slightly, to allow that in the chamber to escape slowly through the small aperture at the side of the screw. In a few moments the cast will be perfectly dry, the steam escaping from the chamber, carrying with it that generated from the moisture in the plaster. Extreme care should be taken that the steam shall escape *very slowly*, as otherwise the plaster may be blown out of the flask into the oven by the too rapid expansion of its vaporized moisture. The completion of the drying process is known by steam ceasing to be given off at the screw cap, G. The drying may be facilitated by placing a small chip of wood between the two parts of the flask when it is put into the chamber, thus exposing a larger surface to the heat and allowing the moisture to escape more readily.

Molding by Dry Heat.—When the investment is dried, remove it from the chamber and insert and carefully adjust the selected blank.; replace the flask in the oven immediately under the screws; see that the two sections are so placed that the guide-pins will enter properly into the lugs; open the screw cap a turn or two to allow the escape of the gas from the hot box; turn down the large screw until it bears lightly upon the top of the flask, and close the machine. In less than five minutes the material will be sufficiently softened to permit the commencement of the molding. The screws will turn readily with the thumb and finger (using the smaller key-wrench) when the blank is properly softened. Close the flask gradually, stopping occasionally if the resistance is too great. Usually, if the temperature is about 300°, the flask can be closed in ten minutes; but if a very thick blank is used, the molding must proceed slowly; the small screws may be used to advantage, and more time, say thirty minutes, may be consumed. As soon as the flask is closed—unless a lock flask is used—the flame should be extinguished, the door opened, and the machine allowed to cool. If a lock flask is used, it may be removed and thoroughly cooled before opening it, the oven being meanwhile ready for another case. The cooling may be accomplished rapidly, if necessary, by placing the flask in water. When perfectly cold, remove the plate from the investment; it will be found enveloped in the tin foil which had been burnished to the wax plate. Peel off the foil. The celluloid will present a hard, brightly-polished surface, received from its contact

with the foil, *and will need no further finishing than cutting off the excess of material and smoothing down the edges.* The extra hardness of the *surface* will thus remain to preserve the integrity and color of the piece. It is claimed, also, that the contact of the foil renders the outer surface, which is always the densest portion of celluloid, much harder.

Imitating Gum Membrane.—The plate produced by the above method is of the ordinary appearance, with smooth, polished gum, but a much more natural, life-like gum will result if the tin foil, after being burnished to the wax plate, is "stippled." This is done by "dotting" carefully over its surface with a dull-pointed instrument, which should be held nearly perpendicularly to the surface to be operated on, and the strokes should be gentle—*not hard enough to perforate the foil.* When the foil is removed, after the case is molded, the gums present an appearance closely resembling the natural membrane. The stippling need not occupy a great deal of time, and the result it produces is a marked improvement.

Metal Casts and Deep Undercuts.—Many dentists who prefer to use metal casts have doubtless found difficulty in removing the finished plates in cases of deep undercut. The fact that a melted metal cools from the surface toward the center supplies an effectual remedy. When the metal is poured into the sand, allow it to chill only about a quarter of an inch on the outside, and then pour the balance out of the mold. This makes a hollow cast or shell. Fill up the cavity with plaster and proceed as usual. After the plate is molded, remove the plaster, place the edges of the metal cast in the jaws of a vise, and crush the shell. This will free the piece without disturbing the teeth. The plaster in the shell also affords the means of attaching the cast to the articulator. A plaster core in the form of a cross may also be inserted when pouring the metal die in the base, which will divide the core into four sections, which may be crushed together in a vise and thus liberate the celluloid plate.

Repairing.—If a portion of a plate has been broken away and lost, fit a piece of celluloid of the proper shape, leaving it somewhat larger than the space to be filled. Make sure that the surfaces to be united are *perfectly clean;* even the perspiration from the hand may cause a dark line. Flask and mold as usual.

A crack in a plate or the parts of a broken plate may be joined by scraping the surfaces clean, or washing them with alcohol, and molding a thin strip of celluloid into the seam.

The following method of repairing small breaks is suggested by Dr. M. H. Cryer, and possesses the merit of extreme simplicity, and its results are in the highest degree satisfactory:—

Remove all portions of the broken tooth from the plate, taking care

not to disturb the outlines of the socket. Select a tooth of proper size and shade to replace the broken one. (If the tooth is numbered, a considerable part of the trouble of selection may be saved by taking the number of the mold from the reverse impression in the plate or from the broken pieces.) Having set the new tooth partly in its place, hold it steadily over the flame of an alcohol lamp, carefully guarding the celluloid from contact with the flame. In a few seconds the tooth will begin to grow warm, and its heat will soften the celluloid sufficiently to allow the tooth to be pressed into its proper position with a napkin. This will cause a small bulge or raised spot to appear in the celluloid opposite the lingual portion of the root of the tooth. Invest in plaster, in the deeper section of the flask, covering the whole plate and the teeth, except the small portion of the celluloid raised in pressing the tooth into place. Complete the investment, part the flask, and dry the case, after which insert a piece of rather thick writing paper or heavy tin foil over the raised spot and place in the oven. Heat up to the usual temperature for molding and close the flask. When the case is cold the tooth will be found firmly fixed in its position, and there will be no mark to show that the plate has been repaired.

In case a small portion of the celluloid is chipped away from the front of the socket—enough only to expose the end of the root when in position—drop a little wax upon the vacant spot after placing the tooth and carve to the shape desired. Without removing the wax, invest and mold as before described. The wax will pass off into the plaster and its place will be supplied by the celluloid, of which there is usually enough to permit the flowing of the minute quantity required without damage.

If there is a similar deficiency on the inside of the plate, exposing the pins of the tooth, drop wax into the vacancy and proceed as before, except that in this case the wax is to be removed when the investment is made, and the bit of writing paper or tin foil is to be placed just below the pins, instead of over them, so as to force the flowing of the celluloid to cover them.

To remove a tooth from a celluloid plate, *hold* the outside surface of the tooth to be removed in the flame of the lamp until the heat softens the celluloid around the pins slightly, when it may be taken off without trouble, and it will come away clean, without any of the celluloid adhering to the pins. Do not move the plate back and forth through the flame, or other teeth than the one desired may be loosened, or their perfect articulation may be interfered with. There is no danger of cracking the tooth so long as the flame does not come in contact with the pins.

Fig. 1164 represents the first process in repairing a celluloid plate from which a tooth or block has been broken. The plate being cut away sufficiently to allow the new tooth to be adjusted by grinding, a new piece of celluloid (*a*) is fitted to the space. The new piece is then removed and its place filled up with wax. Fig. 1165 shows the piece invested in the lower section of the flask, the space filled with wax being the only portion visible, the entire surfaces of the plate and teeth being covered. The upper section of the flask is then adjusted and filled up with plaster. When the flask is opened the wax is removed and the new piece of celluloid returned to its place, and upon it is placed another small piece of celluloid, or a roll of tin foil, to produce pressure upon the new piece first added, the edges of which, as well as those of the space into which it is fitted, being moistened with spirits of camphor or liquid celluloid to bring about union.

FIG. 1164.

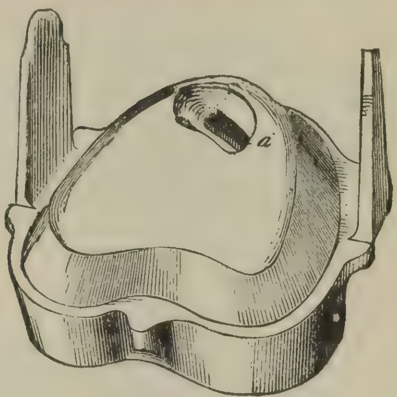


FIG. 1165.

Liquid celluloid is made by dissolving small pieces of celluloid in spirits of camphor. The piece is then placed in the heater and subjected to the usual process. Where the plate is of considerable thickness, a new tooth or block may be added without new material by cutting away as little as possible of the old plate on the lingual surface, and depending upon the thickness of celluloid pressing up, after being softened in the heater, closely to the new tooth. Loose teeth may be tightened in the same manner, wax being introduced into the vacant space and removed after the flasking.

Some object to the use of a solvent in repairing on account of the liability of the newly-added material to become porous. To cleanse celluloid plates previous to repairing, they should be placed in a solution of whiting and water, to which is added some liquid ammonia, and allowed to remain some time, when they are brushed with soap and water, and finally washed in clean water and dried.

NEW MODE CONTINUOUS GUM.

With reference to the second objection to the use of rubber, it is to be said that the perfect reproduction of natural effects and really artistic work cannot be made with block teeth. To obtain the proper expression, each tooth should be available for placing in any position desired, instead of being arbitrarily held in association with others, as in a block.

The invention of the New Mode machine places in the hands of the profession the means for overcoming this objection by using plain teeth with rubber for the base, and celluloid, which is well suited for the purpose, for the gum, the combination forming an exquisite piece of work which the inventor calls the "New Mode Continuous Gum." It is easily the nearest approach to porcelain continuous gum that has been obtained with plastic materials. Its general adoption would do away with "bad joints" and broken blocks, which are so often a source of serious annoyance. It is the only rubber plate upon which a tooth may be replaced without revulcanization, and which after the repair is equal in strength and appearance to the original piece; and the only one upon which repairs can be repeated any number of times without injury to the original plate. This same style of work can also be done with gold and with cast-alloy plates.

Directions for Making the New Mode Continuous Gum.—Using teeth made expressly for continuous-gum or celluloid work, set them up in wax in the usual manner, leaving the front or outside of the roots exposed. Cut a thin strip of the wax, warm it, and attach it to the upper edge of the portion of the wax plate representing the gum, forming a rim which extends all around the outer margin. Finish the palatine surface to the form desired, invest in the flask in the usual manner, remove the wax, pack with rubber, and vulcanize. When removed from the flask the case will present the appearance shown in Fig. 1167, the front or outside of the roots being exposed and the narrow *undercut* rim extending all around, leaving a space with retaining grooves between the teeth for forming a gum of celluloid, looking very much as though the substance of the plate had been gouged out for the purpose. The vulcanite plate is now completed with the teeth firmly attached to it.

To put on the gum, fill up the groove with paraffin and wax (this compound, not being sticky, does not adhere to the instrument and is therefore more easily carved to the form desired) until all the space inside the rim, including the retaining grooves between the necks of the teeth, is occupied. After the wax has hardened, which may be hastened by placing in cold water, carve it into the desired form of

FIG. 1166.

FIG. 1167.

FIG. 1168.

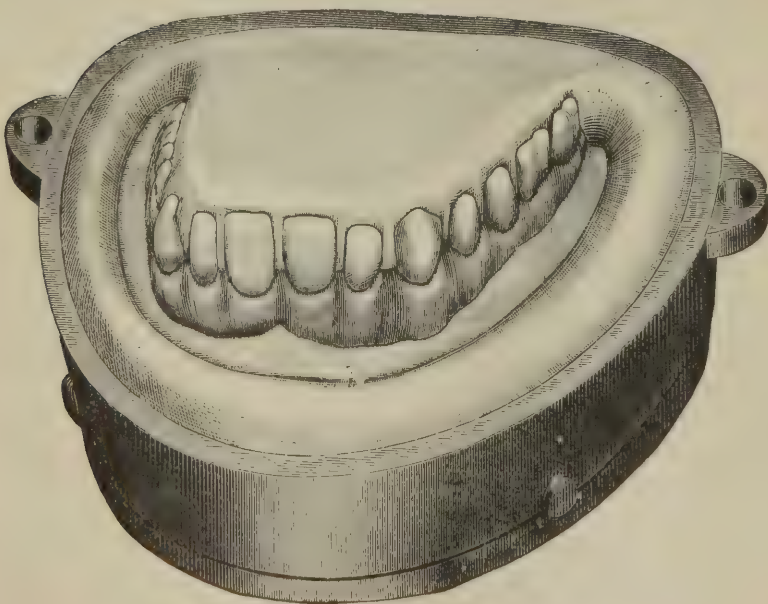


FIG. 1169.

gum. The wax may be made very smooth by throwing upon it the flame of a spirit lamp with the aid of a blowpipe, taking care not to destroy the outline of the carved gum. Cover the wax with heavy tin foil, burnishing it lightly but smoothly to the wax.

Invest the piece again in the following manner: Place the plate in one section of the flask with the teeth upward, and raised at the front at a greater or less angle, as may be necessary, so that when the investment is completed the upper part of the flask may be removed without dragging. Imbed in plaster to the rim and pour plaster over the palatine surface covering the crowns, and taking care to fill the interstices between the necks of the teeth, but leaving their outer surfaces exposed. After the investment sets, pour more plaster around the inner edge of the flask ring, forming a ridge, leaving a groove or space between it and the plate. (See Fig. 1169.) Complete the investment and remove the wax from the groove and interstices between the roots of the teeth by pouring boiling water over it. Having selected a celluloid blank of proper size, saw off the outer rim (see Fig. 1166); warm this rim of celluloid in boiling water, and with the hand and a cloth press it closely about the teeth and hold it to its place until stiff; it will then remain there until the two parts of the flask are entered upon the guide-pins. Join the two parts of the flask together and place the investment in the oven of the machine, having previously heated up the chamber. When the temperature of 280° is reached the flask may be closed. As soon as this is accomplished the case is ready to be removed from the oven and placed in a clamp to cool.

When perfectly cold remove the plate. The tin foil will adhere to it, but it can be readily removed by inserting the point of a knife under the edge and pulling it off, leaving the surface of the celluloid gum as smooth and polished as that of the foil.

A surface produced by the above method presents a smooth, polished gum, but if the tin foil is "stippled," as before described, a striking resemblance to the natural membrane will be produced, the finished plate presenting the appearance shown in Fig. 1168. The adjoining edges of the celluloid and rubber will be found perfectly united, each preserving its sharp outline.

Dr. D. Genese recommends the following method of working celluloid, which will give a hard, smooth, polished surface to the plate when it leaves the heater, regulate the size of the celluloid blank before it is molded to the surface of the metal die or cast and about the teeth, and also form a metal cast, which is easily removed from the celluloid plate after it is completed:—

Two perfect impressions in plaster are taken of the mouth, one of

which is used to secure a plaster model, upon which the trial plate is formed, of wax and paraffin. Upon this trial plate a rim of wax is built, and the exact bite secured. In wax, only the model of the piece desired in the finished case is then formed, which is attached to a metal die, which has been obtained by molding the plaster model in sand. The whole is then molded in sand, and a zinc and lead die and counter-die obtained, by means of which a tin cap (made of rolled tin, No. 29 gauge) is swaged, which will completely envelop the wax model, extend over the gum portion, and to the full height of the finished "bite." The edge of the tin cap, which is left rough, is turned up at an angle of about forty-five degrees, so as to form a support for it in the plaster, when it is invested. The object of this cap is to form a metal mold in which the celluloid blank can be shaped to the form and size desired for the case in hand. The modeled wax is then transferred to the plaster model, which is invested in the lower half of the flask, and the surface of the investment varnished over and oiled, to ensure the required separation. The tin cap is then placed over the modeled wax surface and the upper half of the flask filled with plaster. When the flask is separated, the wax is removed from the plaster model, the tin cap remaining firmly secured in the upper half of the flask. The celluloid blank is then placed in the tin cap mold, and the sections of the flask brought together by being placed in a heater. Upon removing the blank from the mold, in the flask, any excess of celluloid can be removed, and a blank of a proper size and form secured which will not press the teeth out of position in the subsequent molding of the plate. It is necessary to secure a duplicate bite to mount the teeth, which is done on a metal die or cast, formed as follows:—

The second plaster impression is removed from the impression cup and imbedded in a sand and plaster investment as deep as it is desired to have the cast. A right-angle cross, with arms about half an inch wide at the upper surface and tapering to a sharp edge (Δ), is then made of plaster mixed with sand and placed over the surface of the plaster impression in such a manner as to bring the sharp edge almost, but not quite, in contact with the impression surface, where it is secured by sealing the ends of the arms to the margin of the impression. A metal die or cast made in this manner is divided into four sections by the cross-core, very nearly to its surface, and is more readily removed from the celluloid plate after it is molded than the hollow metal cast, as the removal of the plaster core will permit of the sections of the cast being bent away from any undercuts which may exist. After obtaining the form of metal die described, the teeth are mounted upon a trial plate formed over it and according to the duplicate

"bite," and the new wax plate is modeled into the form desired for the finished celluloid plate. An impression in sand of the whole is again obtained, a zinc die and lead counter-die poured, and a tin cap similar to the one first made is swaged. This tin cap forms a complete metal casing, and on flasking, is secured in the upper half of the flask by means of its turned edges. The case is then flasked in the usual manner, and on separating the sections and removing the wax the celluloid blank, which has been previously molded into form, according to the manner described above, will be found well adapted to the mold. The case is then placed in one of the combination heaters and molded at a temperature of 300°, which should never be exceeded; and no pressure should be applied by the screws until this heat is obtained. The construction of partial sets is more difficult, but the process is the same as for entire dentures, a cap of somewhat lighter tin being used. By this process the edge only of the plate and a slight excess of material about the necks of the teeth require trimming off, the entire surface being polished without any scraping away by first using fine pumice and glycerin, and finally whiting and glycerin. The plate should be thoroughly cleansed, after removing it from the flask, of all particles of plaster that may adhere to it, and the entire manipulation be conducted with clean hands and instruments.

A metal cast somewhat similar to the one above described may be made by first molding in the usual manner, and afterward sawing all around the alveolar ridge with a fine saw, leaving only what will hold the parts together. Plaster is poured into the spaces made by the saw, in order to render the cast solid. When the set is finished the plaster is removed from the spaces and pressure made by a vise upon the edges of the cast, so as to crush them in and thus free the plate.

Dr. M. H. Cryer devised the filing of notches in celluloid blanks as in Fig. 1170, when the countersunk tooth-crowns are to be mounted in this material. The suggestion obviates the defects found to attend the mounting of these teeth in the usual way, for the confined air in the cups commonly prevents the celluloid from entering far enough to more than half fill them, and thus the pins are left untouched. As a consequence the teeth come off in the process of finishing; or, Fig. 1171 shows the effectiveness of the plan which provides for the escape of the air, while the plastic promontories enter the countersinks and surround the pins, by means of which the teeth are firmly secured to the plate, on which they thus have so strong a hold that the labial necks of the crowns may, for conformity to the adjacent natural teeth, be quite uncovered by the celluloid (see Fig. 1172), and the mounting be yet a strong one, as is evidenced by the section through plate and crown, Fig. 1173, which illustrates a countersunk tooth

crown. In this instance the short celluloid festoons (see Fig. 1172) lie close upon the gum, which they much more nearly resemble than the dark vulcanite when such a base is made.

When the celluloid blanks are molded upon plaster surfaces, files, scrapers, and fine sand or emery paper are necessary in the finishing process, completing the operation of polishing with whiting or prepared chalk, applied by means of a soft brush wheel. Camphor, applied on a soft cloth, is also used to obtain a polish, especially between the teeth and other places beyond the reach of the brush wheel. Friction with the brush wheel sufficient to heat the plate should be avoided, on account of the danger of changing the shape of the plate and injuring the surface. Dark lines on celluloid plates are often the result of using blanks too wide for the case or too thin in the center, causing

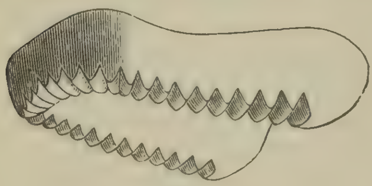


FIG. 1170.

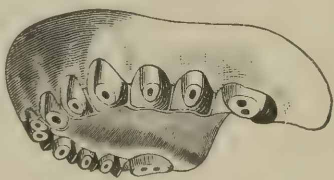


FIG. 1171.

FIG. 1172.

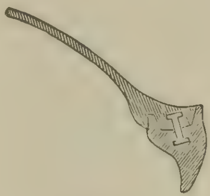


FIG. 1173.

the celluloid to press toward the middle of the plate and fold upon itself. Where the arch of the mouth is very deep, the pressure by means of screws should not be applied before the blank is well softened by the heat, otherwise it may tear apart. Too little pressure, or too little material, may cause a porous plate; also overheating in the dry heat apparatus; the same condition in steam heating may result from too little pressure at the proper time. If the temperature of a celluloid plate is raised to 270°, without any pressure being brought to bear upon it, the material becomes puffed up and is ruined in texture, and cannot be restored by any subsequent manipulation. Celluloid flows very sluggishly, hence sufficient material must be present to insure a perfect plate. The celluloid blank may be softened in boiling water and formed into any desired shape, and an excess at any point may be removed with a sharp knife. It should be remembered that there is no

union between celluloid and rubber, hence when one of these materials is added to the other, it can only be done by dovetailing or drilling holes. Good, hard-setting plaster should always be used in working celluloid, and it should be well mixed by adding it to the water in such a manner that all is absorbed that it will take up. Care should also be taken not to mix the plaster too thin or to use very fine plaster, as a coarse grade of strong plaster will give better results. Some are in the habit of adding clean white sand or marble dust to the plaster. The following directions are given in the use of the New Mode Heater, which will prove serviceable in the working of celluloid generally:—

Always use good plaster, and do not mix too thin; always select a blank which nearly fits the cast, with an excess in *every part;* always turn the screws as soon as they will yield to the thumb and finger, and *always* gently; always follow up the rise in temperature with increased pressure; always give the material plenty of time to flow between the turns; always increase the pressure toward the close of the molding; always reduce the temperature of the piece at once after the completion of the molding, and keep the plate under pressure until it is stone cold.

ZYLONITE.

A modified form of celluloid has been introduced under the name of *zylonite*, the working results of which appear to show a great difference in quality. Zylonite, like celluloid, is composed of pyroxylin and camphor, but in different proportions, being, it is claimed, a chemical combination, while celluloid is a mechanical mixture.

Possessing translucency, the effect of zylonite in the mouth is very pleasing, and, so far as it has been tested, promises to be more durable than celluloid, without the tendency to warp or to change color when ordinary care is taken in its manipulation, which is the same as for celluloid. The zylonite blanks are uniform in color, and although this material requires the same amount of pressure to mold, it flows with a more perfect sharpness of outline than celluloid, and apparently does not disintegrate.

CHAPTER XVI.

PORCELAIN TEETH.

As Pharmacy was once a part of Medical Practice, and instrument-making a part of Surgery, so the manufacture of porcelain teeth was at one time confined to the dental laboratory. Until within the past forty years a practical knowledge of the Dento-ceramic art was con-

sidered an essential part of dental education. Galen compounded his celebrated *Theriaca* for two Roman emperors; Paré and Wiseman made many of their surgical instruments; and necessity has compelled physicians and surgeons in all ages to imitate these examples. But the medical and surgical world have for many years committed the manufacture of drugs and instruments to those who, by making it a special art, can produce far better results.

The time has fully come when Dentistry has done the same with porcelain work, for two sufficient reasons: 1. Manufacturers now offer to the profession porcelain teeth in such variety of beautiful forms that not one dentist in a thousand could equal them. 2. Moderate proficiency in block-carving requires such an amount of preparatory training and of continuous experience, that the dentist's education and practice must suffer in the line of important duties which cannot thus be delegated to others. Hence, nearly, if not quite all, of the most skillful block-carvers engaged in the practice of dentistry have, since the year 1850, one after another, given up this art, which it cost them so much to acquire. For these reasons, and also because the management of a porcelain furnace cannot be taught in books, we shall not attempt in this chapter to give a full and didactic exposition of the manner of making porcelain block or single teeth. Those who desire such knowledge with a view to making it a specialty, require that which no longer comes within the scope of a work on the "Principles and Practice of Dentistry" to teach.

There is, however, on the part of all students, and probably of most practitioners, a desire to know the composition of dental porcelain, and to have some idea of the manner in which a few earthy materials and metallic oxids are made to assume such beautiful forms. Some knowledge of the component parts of porcelain is essential to a correct understanding of the necessity for their admixture, as well as of the effects thus produced.

PORCELAIN MATERIALS.

The infusible earths, Silica and Alumina, and the fusible alkalies, Potassa and Soda, form the bulk of all porcelain. Certain metallic oxids, in small quantity, give color, and some varieties of pottery are modified by small proportions of Lime and Magnesia. Dental porcelain is made from the purest compounds of silica, alumina, and potassa, colored by metallic Gold and Platina, and by the oxids of Gold, Titanium, Manganese, Cobalt, and Uranium.

SILICA.

Silica (quartz, silex, silicic acid) is, next to oxygen, the most universally diffused substance in nature, constituting 50 per cent. of all rocks. Granite, granitic rocks, sandstones, and sand contain not less than three-fourths silica; mica, schist, clay-slate and clay, not less than two-thirds; trap-rocks and lava, one-half. Silica is to the mineral kingdom what carbon is to the vegetable—the element of stability. In its purest forms (rock crystal, Brazilian pebbles, or crystals of quartz), it is free from discoloration by iron or other oxids, it is absolutely infusible, and is insoluble in water; this is the kind selected for dental porcelain, but for other varieties of porcelain flint is commonly used. It forms silicates with alumina, magnesia, lime, potassa, and soda, the most important of which, in this connection, are the silicates of alumina and potassa. Silica, as found in feldspar and kaolin, is partly pure silica, partly the silicate of alumina. Now the "behavior" in the furnace of silica and the silicate of alumina is different; hence, chemical analysis can estimate only the relative purity of these substances; experiment alone can determine the proportions of each necessary for the development of any required property in porcelain.

FELDSPAR.

Next to silica, alumina (oxid of aluminium) is the most universally diffused of all minerals; but, unlike silica, it is rarely found uncombined. The gem Sapphire is pure crystallized aluminium, and is the next hardest mineral to the diamond; a less pure form is well known in dentistry as emery or corundum, some specimens of which seem, under the lens, to be a collection of minute crystals of dark-colored sapphire. For porcelain manufacture, aluminium is never used in its purest state, but in its natural combinations with silica, lime, potassa, and soda. For dental porcelain only two of these are used—Feldspar (known to the Chinese as Pe-tun-tse) and Kaolin. Feldspar is a silicate of aluminium and potassa, containing a little lime and a trace of iron. A less common variety of spar contains soda in the place of potassa; it makes a soft porcelain, fusible at lower heat than the potash spar. Lime feldspar is used in some kinds of pottery, but for dental purposes potash feldspar is the only variety. It is an abundant mineral, and is often found in large masses; the purest varieties alone are used for dental porcelain. Delaware and Pennsylvania spars are most esteemed by American manufacturers. Its most extensive dissemination, however, is as one of the components of granite and granitic rocks, by disintegration of the feldspathic constituents of which large beds of porcelain clay are formed, as found in

China and Japan, England, Germany, and France, and also in the United States.

KAOLIN.—Ka-o-lin (the Chinese word for clay) is the purest of these mixtures of silica and silicate of alumina, prepared in Nature's laboratory for the manufacture of porcelain. Pipe clay, potter's clay, blue clay, fire clay, and Cornish stone are similar in composition, but only the purest kaolin is used for dental porcelain. It contains nine parts of silica and eight parts aluminium; whereas spar has nine parts silica and only two parts aluminium; also spar is made fusible by its silicate of potassa—kaolin has none. Kaolin is, therefore, feldspar deprived of its soluble silicate of potassa (or soda), which has been washed out during the disintegration of the feldspathic rock. It is soft and unctuous, and is highly plastic; pulverized spar on the contrary, is granular or powdery, and is molded with difficulty. Kaolin, like silex, is infusible; under intense and continued heat it shrinks greatly and becomes extremely hard, but it is always porous and absorbent. Silex lessens the contraction of kaolin, spar gives it fusibility; both diminish its absorbent quality, so objectionable in any material that is to be worn in the mouth.

Stone ware, China ware, Wedgwood ware, Parian porcelain, and Dental porcelain vary in their properties because of the different proportions in which kaolin and feldspar are combined, also in the kind of flux used. For instance, the Parian statuettes have kaolin and spar in equal proportions, with about half as much of a flux, made of spar, quartz, and potash. Dental porcelain, demanding less heat, less shrinkage, and a more translucent appearance, has a very much greater proportion of spar. It has required a very extended series of experiments to combine silica, aluminium, and potassa in correct proportions, and to know just which of Nature's compounds it is best to use in order to harmonize the requisites of strength and beauty, so essential to the character of a porcelain tooth.

COLORING MATERIALS.

The foregoing materials give a pure white porcelain of greater or less translucency. It is now required to find substances which will, in the strong heat of the furnace, yield indestructible colors, by skillful combination of which the porcelain may imitate the almost endless varieties of tint in the natural teeth and gum. Of these there are three principal colors and three subordinate ones.

TITANIUM.—The purest varieties of the oxid of titanium are selected; it is found as a mineral in various localities throughout the United States. The crystals are reddish-brown, and have a bright, metallic lustre; they give, when ground, a beautiful yellow, or yellow-

ish-brown color. It is used in the coloring of all *body*, and is the basis of color for the class of yellowish *enamels*.

PLATINUM.—This metal, precipitated from its solution in aqua regia, then washed and dried, is known as platina sponge. It gives a gray-blue color, and is the basis of color for the class of grayish-blue enamels.

GOLD.—Gold precipitate is used to give life and animation to the tooth, producing often a very remarkable effect. The oxid of gold, known as *Purple of Cassius*, and generally considered to be a mixed oxid of gold and tin, is used to impart the well-known red color of the artificial gum; no less costly substitute has ever been found for this purpose.

Oxid of Manganese gives a purplish color, and is used occasionally for some shade of tooth, but not of gum. *Oxid of Cobalt* gives a bright blue color. If wrapped in best blue paper and burned in a covered crucible it is called the ashes of cobalt, and is thought to give a more desirable tint to the enamel than the simple oxid. *Oxid of Uranium* is used in its mineral form and gives a greenish-yellow color; while a lemon-yellow color may be given by the *oxid of silver;* but this is a fugitive color at high temperatures.

These colors, singly and in combination with each other, produce a great variety of colors or shades. Thus, say forty shades of *body color* are made by using these materials in different quantities and in different combinations; also a like number of *enamel colors*. Then, starting with the lightest shade of body, forty different grades may be produced by using a different point enamel; so of each of the forty shades of the body, making, if required, sixteen hundred variations of shade.

The following formulæ will suffice to give a correct idea of the proportions in which the preceding materials are combined to give the BODY and ENAMEL of porcelain teeth, single or in sections:—

BODY.		ENAMEL.	
Feldspar,	12 oz.	Feldspar,	3 oz.
Quartz,	2 oz.	Sponge platina,	1 to 4 grs.
Kaolin,	15 dwts.	Flux,	3 dwts.
Titanium,	24 to 48 grs.		

The FLUX here mentioned is made by fusing four ounces of finely ground quartz with Glass of Borax and Sal Tartar, each one ounce; it forms a transparent glass. The following formulæ show the preparation of Gum Enamel:—

GUM FRIT.		GUM ENAMEL.	
Oxid of gold,	10 grs.	Gum frit,	1 oz.
Feldspar,	1 oz.	Feldspar,	3 oz.
Flux,	8 dwts.		

The titanium, platina, and oxid of gold must, in these recipes, of course, be modified by mixture with other colors to produce the requisite varieties of shade.

BODY FOR MOLDED BLOCK TEETH.

NO. 1.		NO. 2.	
Kaolin,	1 oz.	German clay,	½ oz.
Silica,	3 oz.	Silica,	3 oz.
Feldspar,	18 oz.	Feldspar,	18 oz.
Oxid of titanium,	65 grs.	Oxid of titanium,	65 grs.
Starch,	10 grs. to each ounce.	Starch,	10 grs. to each ounce.

BODY FOR CARVED BLOCKS.

NO. 1.		NO. 2.	
Kaolin,	1 oz.	German clay,	½ oz.
Silica,	3½ oz.	Silica,	3½ oz.
Feldspar,	14 oz.	Feldspar,	14 oz.
Oxid of titanium,	40 grs.	Oxid of titanium,	40 grs.

BLUE ENAMEL.		YELLOW ENAMEL.	
Platinum blue frit,	1 gr.	Titanium,	1 gr.
Feldspar,	1 oz.	Gold frit,	2 grs.
Starch,	15 grs.	Starch,	15 grs.
		Feldspar,	1 oz.

We shall now briefly describe the processes by which the porcelain teeth and sections sold to the profession are manufactured.

PROCESS OF MANUFACTURE.

The silex and feldspar, in their crude state, are first submitted to a red heat, then suddenly thrown into cold water. This is called "Calcining," and the effect is to render them more easily broken and pulverized. All impurities having been carefully removed, they are crushed between flint stones; when fine enough, they are put into a mill, formed of burr millstone, with chasers of the same material. They are ground in water, then floated off, and allowed to settle. The water is then drawn off or evaporated; the silex and spar, dried and sifted, are then ready for use. The kaolin, having been already pulverized in Nature's laboratory, is prepared by washing until perfectly free from impurities, and when dry is ready for use. The flux and frit are coarsely ground, but the coloring materials are reduced to an impalpable powder. All these porcelain materials are combined in proper proportions to form the body and the enamel, then mixed with water and worked into masses resembling putty. When, however, the method of *biscuiting* is adopted the enamels are mixed in a much thinner state than the body.

The unbaked porcelain masses are now ready for the molding room. The molds in which single teeth or sections are formed are made of

brass and are in two pieces—one-half of the tooth being represented on either side. The precise shapes desired are carved out with great care; holes are drilled to receive the platina pins in each tooth; when the two halves are fitted accurately together, with guiding pins for exact closure, the mold is ready for use. The brass matrix must be made about one-fifth larger than the size desired, to allow for shrinkage of the porcelain paste. After greasing the molds, the first operation is, by means of small tweezers, to place the platina pins in the holes made for them (there are many sizes of these pins, differing in length and thickness, to suit the sizes of the teeth). As no piece of mechanism can be stronger than its weakest point, there should always be such a relation between the tooth substance and the pins, as to shape, size, and angle of insertion, that one will be as strong as the other, and both sufficient for all legitimate uses. The strength of pin, without loss of strength in the tooth, characterizes a recent and valuable improvement made by the late Dr. S. S. White, and known as the "foot-shaped pin," illustrated in Fig. 1174. The thickest part of this pin is at the angle, or heel; the point, or toe, runs upward

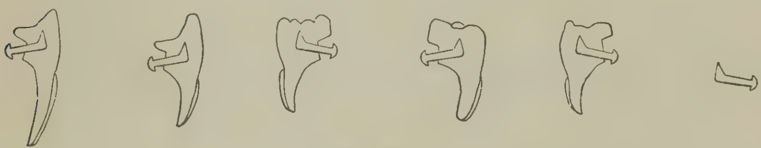


FIG. 1174.

into the thick part of the tooth, giving additional security against its being drawn out. The insertion of the pin at an upward angle beds it in the strongest portion of the tooth material; thus any weakening of the thin portion of the tooth is avoided, as when the headed pin is inserted in a straight line; also, the greatest amount of material is found where the greatest strain is brought to bear upon it. The force of mastication is exerted outward and toward the necks of the teeth; thus the shape and direction of this pin are best calculated directly to oppose it. It will also be noticed that its direction and unusual length of insertion permit a close grinding of the tooth, which would cause the usual short and horizontal pin very soon to break away from the porcelain. The double-headed pin, a previous patented invention of Dr. White, was a very great improvement in the shape of tooth pins; but it has been superseded by this new "foot-shaped pin."

Fig. 1175 represents both plain and sectional gum teeth with the lateral or cross-pins, devised by Dr. C. H. Land, which, it is claimed, give greater strength to the completed denture than when teeth with the ordinary pins are used. For continuous-gum teeth a complete

arch is formed by twisting or soldering the pins together, thus lessening the strain upon any single tooth, and allowing a much lighter plate to be used. What are styled "countersunk teeth" are also manufactured, in which the pins are attached to the teeth in a depression or cavity formed in the base of each tooth. (See Dr. Cryer's method of mounting, in chapter on Celluloid.)

The pins being properly adjusted, the enamels for the tooth and the gum are placed in the molds by means of a small steel spatula, carefully placing them in the exact position and quantity required; the body is placed in them in lumps corresponding to the size of the teeth; the top of the mold is then put on and the matrix placed under a press, which compacts each separate mass. They are then dried by a slow heat. When perfectly dry the top is removed, and the teeth will now drop out. In this state they are extremely tender, owing to the large percentage of feldspar, and require very careful handling.

Ther are now sent to the trimmer's room, where each tooth is care-

FIG. 1175.

fully inspected and all imperfections removed or filled up; the spare edges left by the union of the two sides of the mold are smoothly filed, and the arch of the gum over each tooth made rounding and true with a small pointed instrument. They are then placed on beds of coarse quartz sand, on trays or slides made of fire-clay, and are ready for the furnace. Formerly there was another process, called crucing, or biscuiting, which was universally practiced, and is still used in some factories; it is also used in the making of blocks carved to order. It consists in submitting the teeth after molding to a heat sufficient to harden them so they can be cut or filed like chalk, and what is called an *outside enamel* is then applied with a camel's-hair brush; but it has been found that the composition of the tooth is injuriously affected by this partial burning, subsequent cooling, enameling, and reburning. This process is unavoidable when the blocks are carved by hand for special cases; but whenever they can be made in a matrix, the tooth is

better and stronger when it is enameled in the mold and finished in a single firing.

The furnace is built substantially on the principle of the dentists' furnace (Fig. 1096), differing chiefly in size. The trays holding the teeth are placed in the muffle, and are thus protected against injury from the gases of the fuel. There is no rule which can be given to determine the exact amount of time the teeth must remain in the furnace; the practiced eye of the burner must determine from the appearance of the teeth when the firing is completed. If taken out before they are done the enamel will craze, or crack, in cooling; if a little too much done, the surface will be too glassy and the body will not be strong. When cool the teeth are removed from the slides, placed upon wax cards, and are then ready for the dentist.

The vast variety in shape, size, color, etc., of the teeth thus made gives opportunity for the selection of forms suitable to nearly every case which presents itself to the practitioner. The assortment must of necessity be very large and varied to meet the wants of the operator; in fact, the manufacturer has shown a better appreciation of the esthetic requirements of the dental art than the practitioner. While the work of the latter too often exhibits an unmeaning monotony, the former has made provision for even the extreme cases which are sometimes met with; he has also given a beautiful series of those various deviations from a uniform regularity which are so common in natural dentures. In some mouths these seem to be imperatively demanded to restore the familiar expression, while in any mouth the use of some one or other of them would go far to disarm that suspicion of artificiality detection of which is mortifying to most patients.

Porcelain is a material in which the beauty of the result well repays the highest exercise of Art. It has been for centuries a favorite material for expressing the Poetry of Form. The famous Etruscan vases of antiquity, the exquisite gems of the *Majolica* of the sixteenth century, the marvelous work of Bernard Palissy, the prince of potters, the beautiful productions of the Sèvres and Dresden manufactories, the well-known charming designs of the Wedgwood ware, and the still more recent Parian statuettes, may be named in proof of the fitness of porcelain to embody the conceptions of Genius. Dental porcelain is worthy of such associations; not only like them does it delight the eye and give evidence of high esthetic cultivation, but it adds to beauty the charm of usefulness. It is customary to attribute the rapid growth of Dental Art, since 1840, to its associations, colleges, journals, and its didactic literature—and with much truth. But to porcelain it owes its very existence as an esthetic art, and the larger

part of its extent and utility as a prosthetic art. It was altogether impossible for perishable human teeth, or their wretched imitations in ivory, to offer such tempting fac-similes of nature as we meet in porcelain. By thus creating that enormously increased demand for dental service which has been the chief cause of the rapid development of its resources, it has made the dental profession its debtor to a greater extent than any other single influence. The depot not only renders service by the superior excellence of the surgical instruments and prosthetic materials which it supplies, but it directly benefits the science and art of dentistry by releasing the practitioner from manufacturing toil, and giving time for the acquirement of increased knowledge and skill. Thus, if the time heretofore given to block-making were devoted to the study of dental esthetics, patients would have the benefit of an artistic selection from a far larger variety of porcelain dentures than could otherwise be possibly made. The illustrations of this chapter can but imperfectly convey an idea of the beauty and expression of the originals ; they will, however, assist the student in his study of those principles which guide in the selection and arrangement of teeth ; they may also serve to awaken practitioners to the extent of the present resources of ceramic dentistry, and to the importance of esthetic culture in order to properly make full use of the same.

The improvements in the Dento-ceramic Art have sprung from a careful inquiry into the essential characteristics which artistically formed porcelain teeth should possess. Among these are (1) *Naturalness ;* under which term are included shape, color, and a vital appearance, the last depending upon the precise amount of translucency, the texture of the surface, and the nice blending of the colors of the body and enamel—an appearance which should be maintained as well under artificial as under solar light. Many teeth which will bear inspection reasonably well in daylight have a very unnatural and artificial appearance when exposed in the mouth to a light under which the wearer may be most anxious to excite admiration. (2) *Shape ;* which includes a preservation of the distinctive characteristics of each tooth, securing the instant recognition of its position in the dental arch. There must be some defect or inaccuracy of form if, out of the twenty-eight teeth of a set, in unassorted confusion, an experienced eye cannot tell the place of each ; for every tooth has its distinctive contour. Not only should each tooth possess the individuality which belongs to it, but it should also indicate the character of its relation to its companions on either side and to its antagonist. The eye trained to observe nature should not be offended by the recognition of any inharmony ; should not find a second bicuspid or molar in place of a first, or incisors un-

distinguishable from each other, or an upper tooth in place of its corresponding lower one ; nor should it detect in the midst of one style of denture some incisor or canine characteristic of another. Figs. 1176

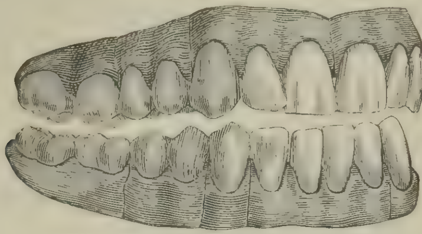


FIG. 1176.

and 1177 exhibit very strikingly the marked peculiarities of each one of the twenty-eight teeth of an artistically designed artificial set ; while these and subsequent illustrations demonstrate how possible it is for

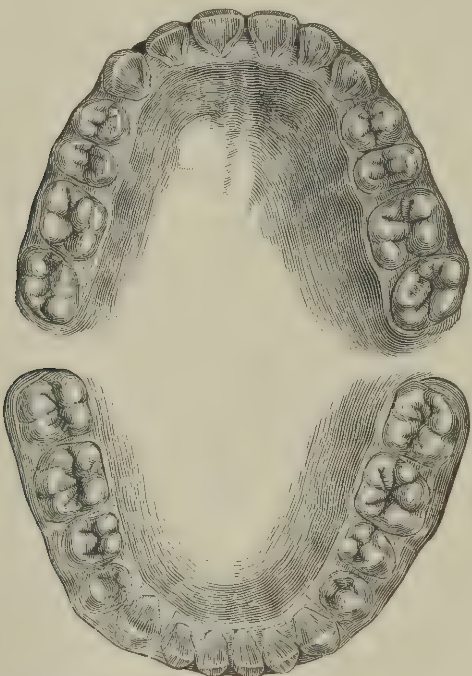


FIG. 1177.

modern dentistry to adapt its work to the great varieties of facial expression. Probably every reader has more than once turned at the

sound of a familiar voice, to see a face strangely resembling the looked-for friend. This correspondence between voice and face, often so startling, is only another one of those links between external and internal conformation, which makes the study of esthetic anatomy essential to the success of the dental mechanician.

The great law of correspondence, which enabled Cuvier to build up the entire skeleton from a single bone, makes us associate the idea of intellect with certain forms of forehead, and of character with certain forms of mouth, nose, and chin ; it is the same law which permits us to infer from what remains the expression of what is lost. Age, sex, temperament, and complexion, also many physical, mental, and even moral peculiarities, are suggested to the acute observer by certain characteristics of the dental organs. The artist who seeks to restore harmony in the facial expression should be skilled in the observance of these varied manifestations ; such skill is demanded alike in the manufacture and in the application of artificial dentures.

In addition to these esthetic qualities porcelain teeth should possess (3) *Strength* adequate to the legitimate use for which they are intended ; this strength should come from the quality of their composition, the skillful distribution of bulk to parts most requiring it, and from the due form, position, and proportion of the pins, rather than from any increase in bulk and weight beyond that of the natural organs. They should possess, also, by reason of their conformation (4) *Adaptability* to the various irregularities caused by unequal absorption of the alveolar ridge, so that when judiciously selected they shall require little labor to adapt and antagonize them. Special provision should be made for the results of extreme or very irregular absorption, or for the loss, by disease or otherwise, of parts of the maxillary ridge, so that in such cases the teeth can readily be made to articulate and afford comfort to the wearer, assisting in speech and mastication, and yet not presenting any incongruous appearance.

There are, moreover, special modifications demanded by many other conditions ; as, for instance, in cases having a very short articulation, requiring the pins to be set in a recess near the crowns of the teeth and also in countersunk depressions under the base of each tooth, thus bringing the greatest resistance where there is the greatest strain in mastication, as is well shown in Figs. 1179, 1201. In both these blocks the full external size of tooth is given, and its characteristic form and the expression of interdental gum preserved ; this could not be done with the usual form of blocks, ground down to suit such cases. In Fig. 1178 we have front blocks for mouths where a shoulder is required to antagonize with the lower front teeth when there are no back teeth remaining. Where early contraction and protrusion of the

upper maxillary arch has caused it to have a sharply curved projection, bringing the closure of the lower teeth much behind the upper ridge

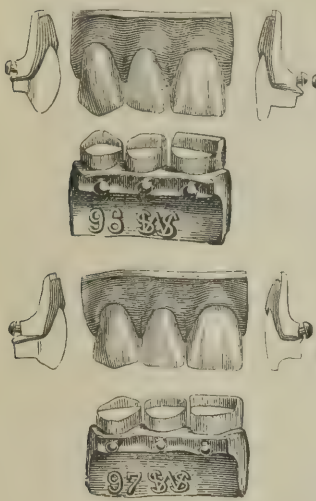


FIG. 1178.

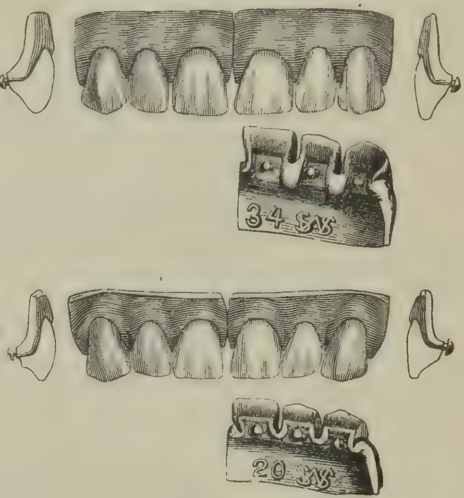


FIG. 1179.

at the central incisors, or where absorption above has left a ridge prominent at its lower edge or margin of the gum, it becomes necessary to give a peculiar twisted form to the front blocks. In Fig. 1180

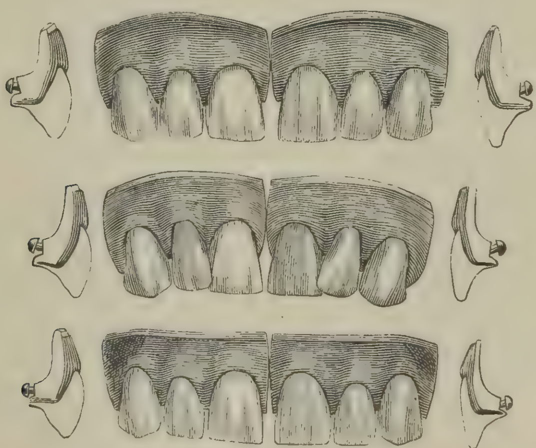


FIG. 1180.

the first two blocks are for a pointed arch, accompanied in the second by a crowded denture, so often seen in such cases. It is impossible to

adapt blocks of ordinary form to such cases without destroying their true expression at one or other of the joints; in fact, much of both gum and tooth is often sacrificed to get correct articulation. The third blocks are shaded with a view to show the fullness of gum at the centrals and its falling back over the canines; this is also shown in the sectional views of the first and third blocks.

For cases in which the lower jaw closes more or less in advance of the upper maxillary ridge, a large gum is often necessary, as in Fig. 1182; but such mouths require a peculiar form of block if the lower jaw has much projection. Where such a prominence of the gum exists, from want of exterior absorption or the previous wearing of a plate, as to require the teeth to be set directly upon the ridge there should be no artificial gum between it and the lip. When the molar block of lower sets extends to where the ramus of the jaw begins to rise, a peculiar plowshare curve of the base is required; such that, while the gum of the second bicuspid lies on the outside of the ridge,

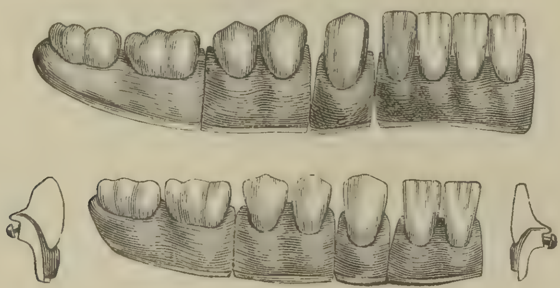


FIG. 1181.

the gum of the second molar may lie partly upon the ridge, so as to give more perfect antagonism with the upper molars. The molar and bicuspid teeth from which Fig. 1181 was drawn are also marked by a characteristic curve of the buccal surfaces, giving not only a very natural appearance, but acting as a guard to the cheek and preventing its being caught between the teeth.

Fig. 1182 illustrates the difference of shape required for a mouth where front absorption permits the artificial gum to overlap the alveolus, and one where fullness of the natural gum requires the block to set directly upon it. In the latter case, if the color of gum is judiciously chosen and the blocks well adapted, the triangles of artificial gum will be scarcely, if at all, distinguishable from the natural; we regard this as an extremely useful form of block. Sectional view of the molar in the upper cut shows the curve necessary to bring its grinding surface directly under the ridge; the views of grinding and

cutting surfaces, together with front views, show how each tooth has a distinctive character; as, for instance, in the bicuspids, so often chosen without regard to the difference in form between the first and second. Again, the curve of the front block shows two of several variations required in the curvature of the arch; in the upper, the sharp turn at the canine gives a squareness across the incisors; in the lower, this turn is at the central and is adapted to a pointed arch. Variations in

FIG. 1182.

curvature of the arch are also shown in Figs. 1177, 1190. Notice also the marked difference in the character of the bicuspids and molars in upper and lower cuts and the totally different expression of the front teeth.

Fig. 1183 shows how the same intermaxillary space may be filled with teeth of a widely different size as well as character. In the first, a very long tooth and short gum; in the second, a very long gum and

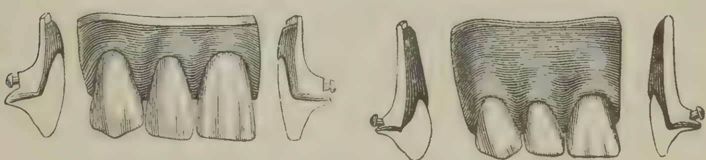


FIG. 1183.

short tooth. But length of teeth is by no means the only difference here; relative size of central and lateral, direction of the axis of lateral and canine, and outline of cutting edge of the block, are three features which equally mark the distinctness of these two styles; these also are points which demand that both long and short teeth shall differ among themselves as widely as these samples differ from each

other. The lateral view of these teeth shows another marked difference in form.

Fig. 1184 gives the characteristic equality of lower incisors, or slightly greater size of the lateral; it also gives some of the diversities in length, width, shape of cutting edge, and form at arch of the gum. Although there is much less difference in the shape of the six lower front teeth than of the six upper, it is a great mistake to suppose that a

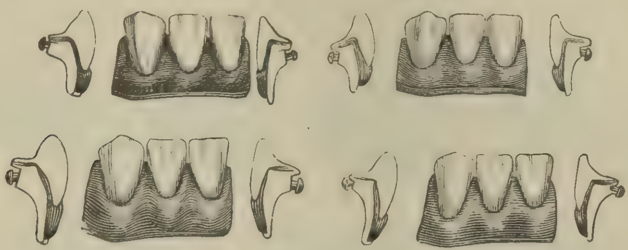


Fig. 1184.

given lower block will answer for any lower case if only long enough. Side views show also a difference in the slant of the teeth, inward or outward, which has an important effect in modifying the expression of the lower arch. There are also differences in curvature of the lower arch as well as of the upper. Fig. 1177 shows the usual upper and lower curves, and Figs. 1182 and 1190 show variations of upper curvature requiring some modifications of the lower, dependent on the

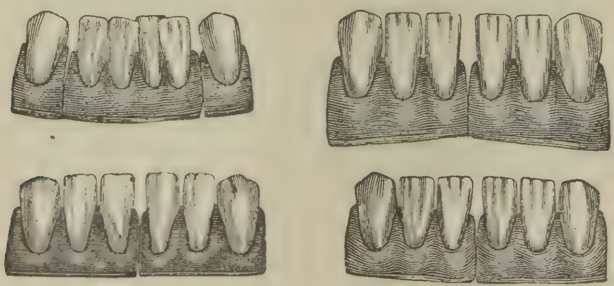


Fig. 1185.

character of the articulation. In Fig. 1185 are four other forms of lower front blocks, the value of which will be at once recognized. The two right-hand sets differ from those of Fig. 1184 mainly in the length and width of teeth. The left lower set is well suited to patients whose natural teeth, for many years before their loss, were marked by exposure of the neck; this appearance may also be increased (sometimes it may

be made) by judicious use of the corundum wheel, but the block here given is invaluable in such cases. The left upper block is an admirable imitation of a very usual arrangement of incisors, resulting from crowded dentition; the drawing gives a very imperfect idea of the great beauty of the original porcelain block. When the facial expression indicates its use, it will have great effect in disarming suspicion of artificiality—a very desirable quality in artificial dentures.

In Fig. 1186 we have very convenient modifications to suit front

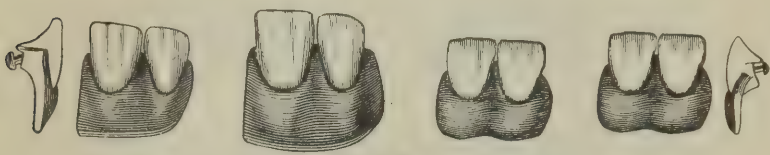


FIG. 1186.

spaces of two or four teeth, the set of four being in two blocks. The peculiarity of these blocks is the lateral finish of the gum; instead of a square joint, for fitting to an adjoining block, they have a rounded edge of gum color that can be adapted to the curves of the absorbed natural gum. There should also be blocks of two, a lateral and central, with gum shaped like the double central, as such spaces are of frequent occurrence. Besides the four forms of teeth here given there

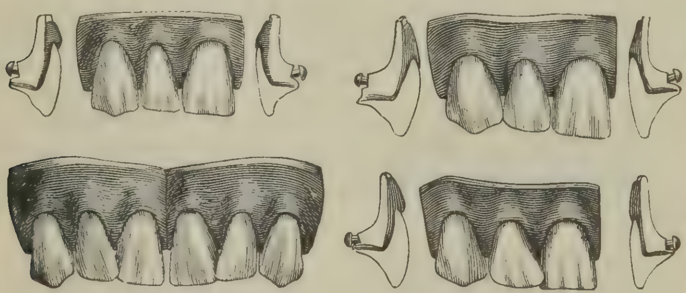


FIG. 1187.

are many other varieties in size and shape of this very useful kind of block.

Figs. 1187, 1188, and 1189 represent a few of the great variety of forms of upper incisors and canines designed to meet the demands of an esthetic discrimination. In Fig. 1187 we have, first, a long, delicate lateral, with sloping but not rounded edge, showing a decided space between it and the cuspid and central; then we find it wider, with corners and edge rounded and filling the space. Lastly, for want of space, the laterals, although long and narrow, overlap the centrals;

this style is generally accompanied with a pointed arch. The fourth block, although with an overlapping incisor, has an entirely different character; it is often found in a rather flattened arch and does not indicate a crowded denture. In these blocks the inclination and shape of the canine as well as the shape of the incisor help to give to each block a distinctness of character which will not permit the use of one in a case demanding either of the others.

The *celare artem* effect of overlapping or twisting laterals, like that of irregular lower incisors, is such as to tempt one to use them whenever admissible. In Fig. 1188 we have some additional varieties of this kind of block. In all these six cases we find differences in the size and character of the lateral, in the extent of its lapping, and in the degree of twist given to it. A careful study of the natural teeth will teach the dentist what character of face is best suited to each of

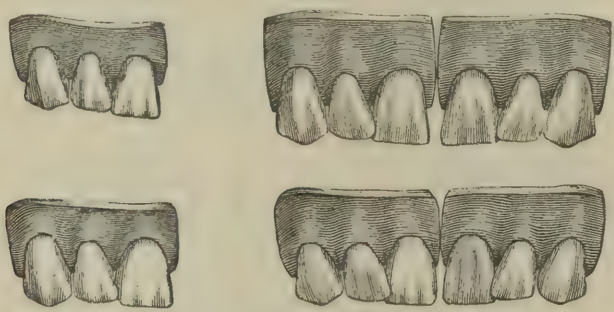


FIG. 1188.

these different forms, and thus he will much increase the extent to which he may properly use this kind of irregularity.

In Fig. 1189 the blocks vary little in size, yet they each have a distinctive character. In the first we have lateral rounded on both corners and its axis vertical; canine, with pointed cusps and edges quite rounded. In the second we have lateral inclined, with median corner pointed, lateral corner quite round; canine with blunt cusp, also axis inclined. In the third, surface of the canine is decidedly furrowed, which, with the indented edge, gives it a marked character; the lateral and central, unlike the previous blocks, have square-cut edges with corners but slightly rounded. In the fourth, the lateral is more nearly equal to the central, and none of the teeth may have any marked peculiarities; this style of block, in its different sizes, suits well in many cases, and is perhaps one of the best for general use by those practitioners who pay no regard, in their selection of teeth, to the indications given by the physical characteristics of the face and head.

The fifth block is one of that class often met with in old age, where, by the action of the lower teeth or other causes, the arch has spread, widening the interdental spaces. The interdental gum is also much shorter than in youth, as is finely shown in the original from which this cut is taken.

In the selection of porcelain blocks not only must the color, size, and form of the teeth be carefully considered, but reference must also be had to the curvature of the arch. For although moderate variations in curvature can be fitted by the same set of blocks, the true expression of a porcelain denture is often lost by the attempt to adapt it to a curve for which it was not designed. In Figs. 1177, 1182, and 1190 we have various curves of the alveolar arch, with corresponding variations in shape of the blocks. Sometimes the canines are made separate with a view to increase the range of application of

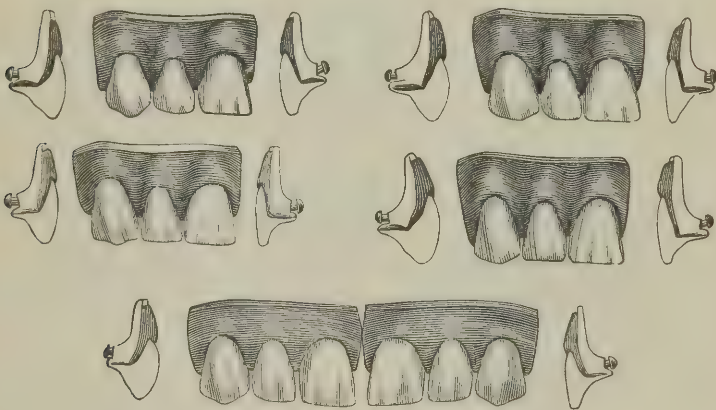


FIG. 1189.

a given set; but a joint on either side is very apt to injure the effect of this important tooth. In the lower jaw it is of less consequence because the gum is less often exposed, and it is frequently desirable to make the four incisors in one block. But in the upper jaw it is much better to have a median joint and another behind the canines.

In Fig. 1190 the reader will notice that the centrals of the first set overlap the laterals, an arrangement of frequent occurrence in prominent and sharply curved arches. It will be observed that in Fig. 1180 the blocks are so shaped that the right or left central overlaps its fellow. Thus we have three varieties of overlapping upper teeth—laterals over centrals, centrals over laterals, central over central—each of which may be used with great effect if applied with discrimi-

nation. In the third set of Fig. 1190, and in a few of the preceding cuts, the gum over the cuspids is very strongly marked. This is a very characteristic feature of some mouths, and when correctly used gives a fine effect; but it would sadly belie the expression in a timid and gentle lady's face. Yet such incongruity is

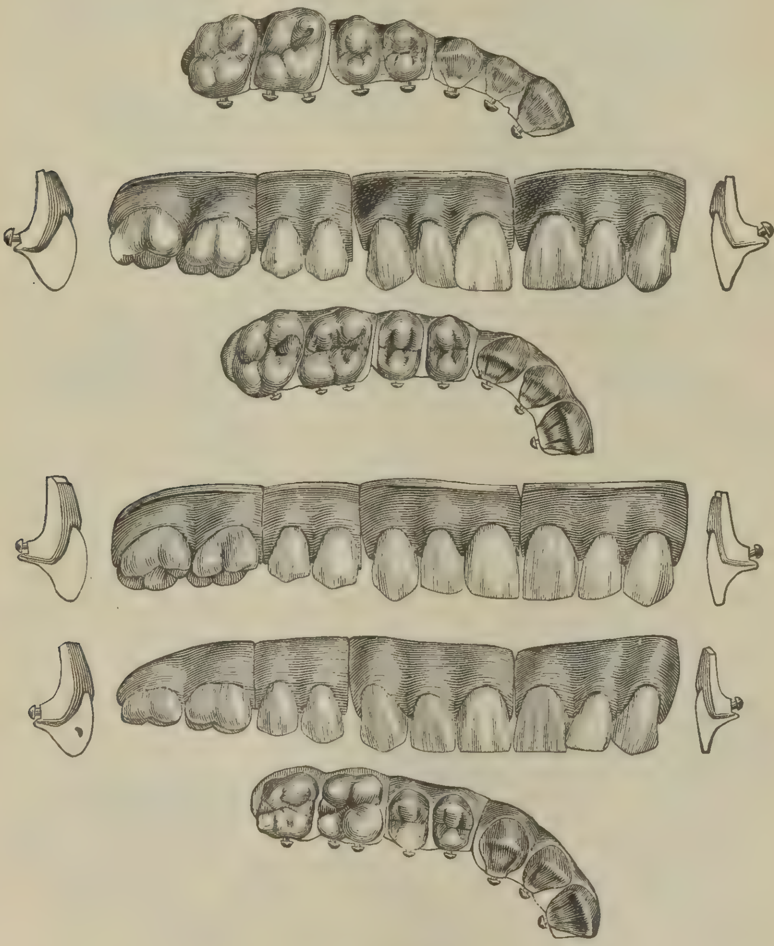


FIG. 1190.

only one of hundreds constantly occurring, where every sense of esthetic beauty and harmony is violated—teeth of a Russian in the mouth of a Frenchmen, those of a New Englander given to a South Carolinian, or those of a Canadian to a Cuban, the lips of age disclosing the teeth of youth, and no distinction made between

a male and female denture. These esthetic blunders are not confined to the inexperienced tyro, but are perpetrated by many who presume to call themselves skillful mechanicians. When we consider the exten-

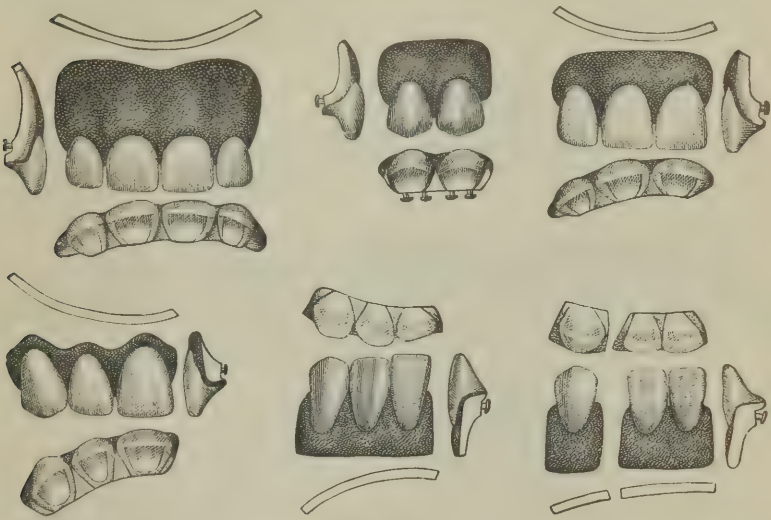


FIG. 1191.

sive assortment of porcelain teeth which ceramic art has placed at the disposal of the practitioner, such malpractice is without excuse.

These are only a few out of the great number of varieties, in size, form, and arrangement, of porcelain teeth; they give to the dentist

FIG. 1192.

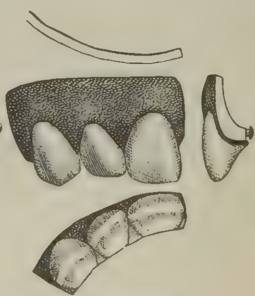


FIG. 1193.

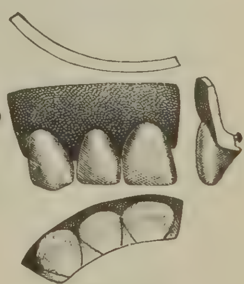


FIG. 1194.

a much wider range of selection than some have the ability or inclination to avail themselves of. When to variety of shape we add shades of color, the number of sets that admit of being made, distinguishable at a glance from each other, seems almost infinite. A visit to a first-

class porcelain-tooth manufacturer's rooms will convince any one that incongruity or want of expression in a set of teeth is the fault of him who selects and applies, rather than of him who designs and makes dental porcelain.

Fig. 1191 represents upper and lower gum sections of four, three, and two teeth, one of the upper sections having partial gums.

Fig. 1192 represents an irregular gum section with the lateral out of line.

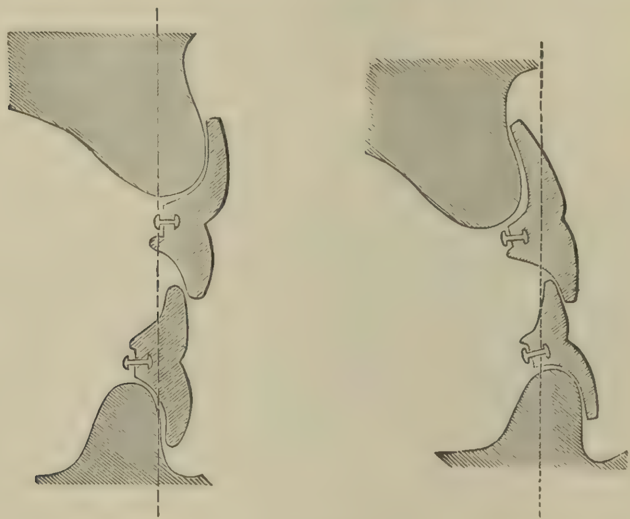


FIG. 1195.

FIG. 1196.

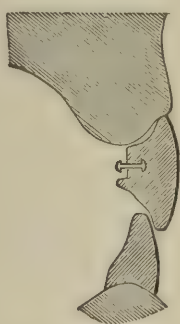


FIG. 1197.

Fig. 1193 represents a gum section with an extra long central incisor.

Fig. 1194 represents a thin gum section.

Fig. 1195 represents gum sections for protruding upper and lower jaws.

Fig. 1196 represents a shouldered gum section.

Fig. 1197 represents a festooned gum section.

Fig. 1198 represents a gum section for a V-shaped protruding upper jaw; the position of the lower teeth is shown by the dotted lines.

It will be perceived that the foregoing illustrations* of the esthetic principles of the dento-ceramic art are taken from one class of teeth, those for vulcanite or metallo-plastic work. We have done so because the art has here had its fullest recent development in consequence of the great demand for this form of block. But dental esthetics is quite independent of the material of the plate, so long as that which is visible in the mouth is porcelain; and dentures which show any substitute for the gum other than this, however useful they may be, cannot rank as specimens of highest art until some material for the plate shall be discovered possessing higher claims to beauty than any yet known.

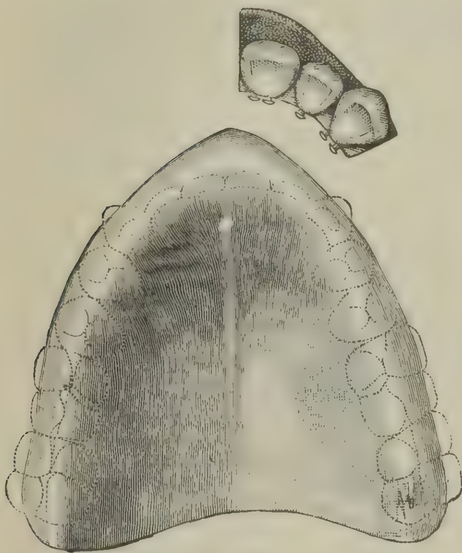


FIG. 1198.

The foregoing rules will apply to the form and size of plate teeth when these are set directly upon the natural gum; but, except in case of true pivot or plate-pivot teeth, it is impossible to reproduce the precise natural arching of the gum above the tooth without some gum-colored porcelain. We must often be content in such cases with the nearest possible approach to nature. But when the plate is seen on the outside of the arch, the artist's reputation is dependent upon the concealment of the greater part of his work; even here, however, the cutting edge and two-thirds of the tooth permit the display of great varieties of expression. Of

* We are indebted to the kindness of the late Dr. Samuel S. White, and more recently of the S. S. White Dental Manufacturing Company, of Philadelphia, for the admirable illustrations by the aid of which we have been enabled to express our views upon the important subject of Dental Esthetics. No illustrations, however, can convey a true idea of the high artistic excellence of those forms the production of which has placed Dr. White among the greatest benefactors of Dental Art. We take this occasion to acknowledge, also, the liberality and courtesy with which our inquiries for information on the manufacture of dental porcelain were responded to by this gentleman.

plain teeth without gum there are four kinds. 1. Pivot teeth; shaped somewhat like the crowns of the upper incisors and canines, with a hole in the base for insertion of a wooden or metallic pivot. 2. Plate teeth; the oldest known form of porcelain teeth having pins for attachment of a back by which to secure it to the plate. 3. Continuous-gum teeth; resembling natural teeth in having a root, which is more or less serrated, for better retention in the investing porcelain base; they are sometimes made without platina pins; but they are better with pins, so that they may be securely fastened to the platina plate. 4. Plain vulcanite (Fig. 1206); having a small neck, by which they are held in the vulcanite or other material in which they are set. These teeth may be set directly on the gum by grinding off the neck; they may also be used adjacent to natural teeth with exposed neck, by slight alterations of this neck, so as to give to the artificial tooth the same appearance as the natural one.

There are also other forms of gum teeth besides those above represented. Formerly, single gum teeth were extensively used on gold plate, and may still be occasionally required when the supremacy of that old-fashioned material becomes once more recognized in the laboratory. The great facility of adapting blocks or sections in vulcanite work or in vulcanite attachment to swaged plates has led to the almost entire exclusion of this form of tooth except for repairing. A serious objection to single gum teeth is the number of joints; these greatly mar the artistic effect which it is the design of the artificial gum to produce, especially when not kept perfectly clean or when the material of plastic plates is allowed to enter the joints. Figs. 1176 and 1199 are designed to show the importance of correct and accurate grinding in order to display the true character of a set of teeth. When properly done, the joint does not interrupt the continuous surface of the gum more than the lines in the two lower sets of Fig. 1199, nor should it in any case be more visible than the heavier lines of the first set. Neither should the set be so inaptly chosen as to require such grinding of joints and base as to injure its original expression. Figs. 1176 and 1199 should also be carefully studied by the student on account of the varieties of form and relation of teeth presented, each of the four upper sets here displayed having a very distinctly marked character.

Porcelain blocks which are to be attached to a gold plate by soldering do not differ in external appearance from the forms already illustrated; but the shape of inner surface and the form of the pins are different. Fig. 1200 represents such a set of upper blocks in three sections. If made in four sections, the set should be divided between the centrals and between the bicuspids; it may also be in five sections;

the four joints being in front of the cuspids and behind the bicuspids; or it may be divided into six sections, as in Fig. 1176. The line above the pins in Fig. 1200 marks the division between the inner slope of gum next the teeth and the plain surfaces holding the pins; this surface should be as smooth as possible for the perfect adaptation of the gold backing. Blocks may also be made in sets of three or five sections, with the inner surface finished in gum enamel to the plate; in this case the block is held to the plate by pins passing into holes made in its base, one opposite each tooth. The best material for retaining the pins is undoubtedly vulcanite, as described in the previous chapter; the holes should be rough, for its better adhesion.

Fig. 1201 represents the "Countersunk Tooth Crowns," which allow of great facility of adaptation to the maxillary ridge and (it is

FIG. 1199.

FIG. 1200.

claimed) afford the strongest denture on a plastic base. To insure the best results some precaution is necessary in mounting them, whether on rubber, celluloid, or metal.

For a vulcanite base the case should be flasked as usual, but each countersink should be carefully filled with small pieces of rubber; otherwise the flat rubber sheet will cover the mouths of the countersinks and so shut in the air as to prevent the rubber from reaching the pins and filling the cavities.

When the base is of celluloid the countersinks must be filled in like manner, with pieces of celluloid moistened with spirits of camphor, or preferably with a solution of celluloid, and the case heated to softness before closing the flask.

For a fusible metal base the hot flask should be jarred during the pouring to drive the air out of the countersink.

Fig. 1202 represents perforated bicuspid blocks.

Fig. 1203 represents rubber bicuspid blocks with pins.

Porcelain teeth are now manufactured for vulcanite work with de-

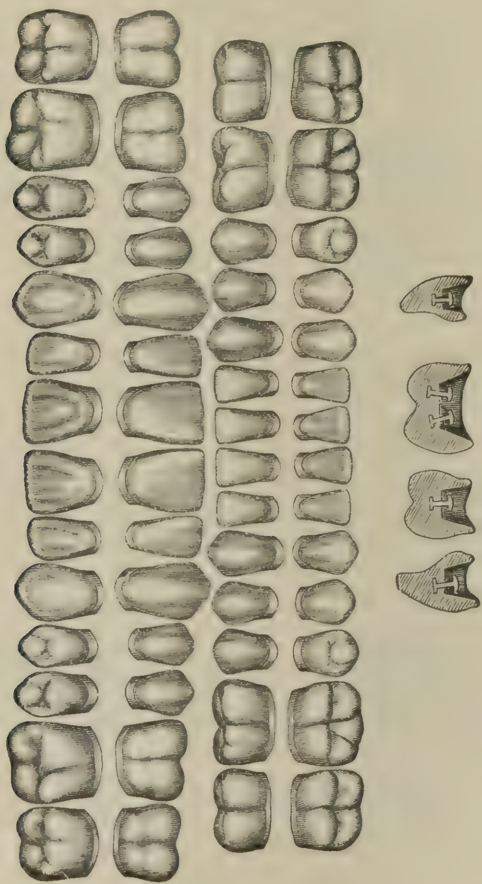


FIG. 1201.

tachable pins which are inserted into dovetailed grooves when the case is being packed.

The dental depots cannot keep on hand an assortment of such blocks, since the demand is too limited to justify the expense of the brass moulds. But in all our principal cities there will be found one or more dental-block carvers, whose experience and constant practice enable them to make any style of blocks that may be de-

sired for special cases. We have elsewhere given our reasons for thinking this a better plan than for the dentist himself to attempt occasional ceramic experiments. Let him prepare an accurate articulating model and adapt a tin-foil plate (to avoid the risk of sending the gold one); then select one or more teeth to guide the carver in the required color and character of the set. If any peculiar form or deviation from the normal arrangement is desired, this should be represented in wax; then pack carefully and send to the block carver. This plan is recommended to those who may desire, for some special

FIG. 1202.

case, a form of blocks not to be had at the depots. Necessarily such blocks are much more expensive than those made by the quantity in brass moulds; but if the dentist values his time, the blocks would cost still more if made by himself.

The true question is, however, not one of cost; if the depot can furnish the form of blocks which the case requires, it is best to get them there, otherwise they must be had elsewhere and at any cost. Dental tradesmen, who sell their wares at a moderate advance on the

FIG. 1203.

cost of production, may not deem it prudent to deal in such high-priced materials; but the professional dentist, who charges for "services rendered," will never find it necessary to hesitate incurring *any* expense requisite for the perfection of his work. The actual cost of material in single dentures has often exceeded thirty dollars; yet the mechanician who exercises a skill commensurate with this cost never has found, and never will find, difficulty in adding a just compensation for his time and skill. As a rule, patients will

pay best for art when exercised on expensive material, except where, as in painting, the effect produced is wholly irrespective of the cost of the means employed. The true basis of professional fees lies in that which makes one man's work superior to another's; namely, artistic skill exercised upon materials, the quality of which shall not detract from its just appreciation.

As we have briefly described the processes of manufacture of porcelain dentures on a large scale—a work which, of course, no practicing dentist proposes to engage in—it is proper that we should also give a brief description of the processes by which blocks are carved for special cases, although we regard this as equally out of the line of the modern dentist's duties. We occasionally find a genius whose gift shows that ceramic art, not dentistry, is his true profession; but men engaged in ordinary dental practice must, in justice to their patients, make use of the experience of professional block carvers, or they must use those forms offered by the ceramic manufacturer, which are the results of the highest artistic skill which money can command.

SPECIAL BLOCK CARVING.

To make a porcelain dental arch in three sections for a full upper case antagonizing with natural teeth below, make a plaster articulator, as described in the tenth chapter, but having greater thickness to permit guiding holes or grooves, as in Fig. 1204. Open the articulator, increasing the space one-fifth (unless this one-fifth enlargement is to be made by addition of point enamel); place on the plate a wax rim, and trim it to antagonize with the lower teeth, giving the precise external fullness required in the blocks. Mark on wax and front edge of articulator the medial line and the lines of proposed division of blocks; that is, between bicuspids for a four-block piece and behind cuspids for a piece of three blocks; in either case the work is carved in three pieces. It is also well to mark, in fainter lines, the width of each tooth as determined by the size of the lower teeth; this will be some guide in the subsequent enlargement required on account of shrinkage of the porcelain paste. Next make a plaster rim about half an inch thick (Fig. 1027, on page 921, shows the height and thickness), covering the exterior surface of model and wax, making first the front section, extending a half tooth space behind the lines marked for the block joints; then remove this and make the two side sections, extending each a half tooth space in front of these lines. The use of a leaden band and some paper pulp will expedite the making of these plaster sections; they should be trimmed to the exact length required for the crude blocks. Of course, neither in plaster nor porcelain can the front and side sections be applied to the

model or plate at the same time, in consequence of the one-fifth allowance for thickness.

On removing the wax, each plaster section is a matrix to determine the external fullness of the corresponding block, on which is to be carved the shape of teeth and gum. The plate gives exact form to the base of the block ; but when finished it will require grinding, because of the derangement of fit caused by shrinkage. The thickness and interior form of the sections is determined by the eye, and will vary with the style of finish or mode of attachment, being careful, in this direction also, to make the one-fifth allowance for shrinkage. The front block is first made and removed, then each side block separately ;

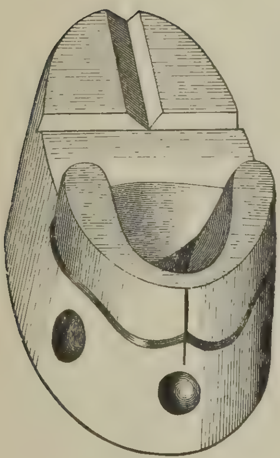


FIG. 1204.

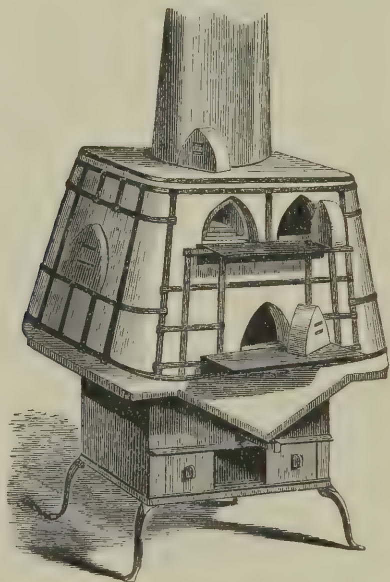


FIG. 1205.

in a double set, both front blocks are made, then both right sections together and left sections together, so as to obtain their proper antagonism ; also, in double sets, the separation of the articulation must be sufficient to allow the one-fifth enlargement in each set.

The porcelain body is prepared as already explained ; it can be compounded by the dentist or purchased from the manufacturer. In mixing the small quantities required for single cases, two points demand special care—purity of the water and absolute exclusion of air from the mass. It must also be remembered that irregular contraction, or warping of blocks in firing, is often caused by unequal compression in pack-

ing the body into the molds and by unequal absorption of its moisture by the porous plaster rim or other means used to dry it. Again, it should be remembered that in removing the rim, in carving, and in all other operations on the crude paste the excess of feldspar gives it a tenderness very different from the tough plasticity of a kaolin mass. The putty-like body is to be carefully worked into the well-oiled mold, compressed with the fingers, trimmed into outline shape, and then removed, first marking upon it the lines of the articulator to guide in the carving. The block may be partly or entirely carved while on the articulator; but the delicate movements of the very delicately-shaped carving tools are, in the opinion of some, best exercised upon the free block.

For carving no directions can be given beyond what has heretofore been said on the necessity of a close observance and exact copying of nature. The artist requires no written directions, and paper instructions never yet made an artist out of a bungler; in fact, the heaven-born genius of art cannot be created by teaching, however it may be trained and directed. Many have wasted years in porcelain block carving only to produce results surpassed by the least artistic forms offered in the depots; while, on the other hand, some dental Palissy will work out a marvel of beauty that no purchased blocks can equal. But before one imagines himself a Bernard Palissy let him read the history of that wonderful struggle of genius, then ask how far the routine duties of a dental office will permit an exclusiveness of devotion which ceramic art rigorously exacts as a condition of success.

When carved, the blocks are thoroughly dried, then placed on coarse silex upon a fire-clay slab, and set into the muffle of the furnace (Fig. 1205). Here they are biscuited (or cruced), that is, raised to a red heat sufficient to give some hardness, but not to vitrify or even to cause incipient fusion. They are then slowly cooled and holes drilled for the pins, or else holes drilled into the base of the blocks, as may be preferred; the pins are fastened in place by a little "body-slip," carefully worked in with the knife point. Slight defects of carving may now be corrected; the enamels are then applied with a camel's-hair brush. They must be reduced to the consistence of cream, and require much skill and judgment in their application, so that the point enamel shall blend properly with the body enamel; also the gum enamel must preserve its distinctness of outline and, by its varying thickness, give those alternations of shade observable in the natural gum. It should here be remarked that some carvers make no allowance in the body for shrinkage in length of the tooth, but compensate by the addition of point enamel. The crowns of bicuspids and molars are usually enameled; also part of the inner surface of the blocks, and in some

blocks the gum enamel extends to the base. When platina pins are inserted, the part of the block to be covered by the backing is not enameled. It is scarcely necessary to remark that a large assortment of body, point, and gum enamels is required ; also that these must, with great care, be kept separate, with their respective test pieces attached, for except by the pinkish color of gum enamel they cannot be distinguished when in form of powder, paste, or cream.

The blocks are now well dried and are ready for the furnace, Fig. 1205. (For other forms of furnaces see article on "Continuous Artificial Gum.") Success thus far is dependent upon: 1. Thorough mixing of the body and its careful packing ; 2. Skillful carving, so as not only to give the required expression, but also to know what allowances to make at each point for shrinkage and for the subsequent application of the enamels ; 3. Selection of enamels and their skillful blending and shaping ; 4. The giving of such form, in adjustment of the relative length and thickness of each block and apportionment of material, as shall prevent warping in the furnace. These points, however, may have been perfectly attended to ; yet all will have been done in vain, unless the operator has a thorough practical knowledge of the management of the furnace. It is this which makes the ceramic experiments of the practicing dentist so often a failure ; for fail he certainly will unless he knows the exact heat at which the differing fusibilities of his body and various enamels will, by their combined effect, develop the properties aimed at in their combination. Some are governed in this by test pieces ; the experienced workman, guided by constant practice in a way that he cannot explain, prefers the indications offered by looking at the piece itself. If not sufficiently baked, the body will be porous; also, neither this nor the enamels will have their true life-like character. If overdone, there is an offensive, glassy, and transparent condition, equally fatal to the natural appearance ; also, there is too much shrinkage and greater danger of warping. Both errors impair the full strength of the porcelain, in which the ingredients are so combined as to develop greatest strength at a certain temperature.

Furnace temperature is measured by instruments called Pyrometers. The limit of mercurial registration of temperature is 600° Fahrenheit. Daniell's pyrometer registers by the expansion of a platina rod in a plumbago case and is the most accurate. Wedgwood's pyrometer registers by the rate of permanent contraction of kaolin under intense heat. A clay wedge fitting the upper part of a tapering groove will, after exposure to furnace heat, slip further into the groove ; supposing the rate of contraction uniform, this distance will be a measure of the heat after establishing its exact relation to the 600° point of Fahren-

heit. But the contraction of any two pieces is not the same unless their composition is identical; also, the relation to the mercurial scale is not easy to determine. Wedgwood's zero was 1076° Fahrenheit, and he estimated one degree of his pyrometer equal to 130°; on which basis of calculation the highest heat of the porcelain furnace (130° *to* 160° Wedgwood) would range from 19,000° *to* 22,000° Fahrenheit. Others estimate his degree at 62.5° Fahrenheit, reducing the registration from 9500° *to* 11,000° Fahrenheit. Taking the fusion point of gold at 2000°, and of pure iron at 3000°, we thus have some idea of the infusibility of platinum and the extreme heat of ceramic furnaces. But it is evident that the correct regulation of this heat must be the result of experience rather than of written direction; also, that the furnace practice of different persons cannot be accurately compared.

The muffle protects against the gases of the fire. Charcoal, coke, or anthracite are used as fuels, according to the location of the operator; the last is preferable when it can be procured, because it gives the steadiest heat; charcoal requires practice to maintain a uniform heat; coke is used in all the bituminous coal regions. With either of these, after sufficient experience, a furnace may be kept regularly at the required heat for a length of time sufficient to fire the porcelain blocks. They must be thoroughly dried on the furnace-shelf before going into the muffle; the mouth of the muffle should be well luted, and the stopper withdrawn only to examine the work. The more slowly blocks are cooled, the more perfectly are they annealed, and hence less liable to crack from sudden changes of temperature, as in soldering.

Not to interrupt the order of operations, we have deferred the description of a very ingenious method of carving devised by Dr. William Calvert. Instead of the wax rim before mentioned Dr. Calvert provided an assortment of teeth having all the varieties of form and size required in practice, but one-fifth larger than the given case. These are arranged in a wax gum and the plaster mold then taken. Thus, in Fig. 1206, teeth of the first size set in wax will give, when diminished by the furnace, teeth of the second size; so in Fig. 1184, each of the two lower sizes in wax will give in the finished block the size above it. Dr. Calvert's method has three recommendations: 1. Like continuous-gum work, it limits the necessity of esthetic skill (which so few possess in high degree) to the shaping of the gum, the judicious selection of teeth, and their proper arrangement, leaving the details of form to the genius of the manufacturer's artist. 2. It permits the application of enamels, or rather the addition of body to enamels, without the necessity of crucing, which some

regard as injurious to the tooth. 3. By selecting a variety of styles of model teeth, and by varying the relative adjustment of them in the wax, that tendency to uniformity of style is obviated which characterizes almost every block-carver's work.

Dr. Calvert's process differs mainly from the foregoing in the following details: For a four-block piece the teeth are set in wax shaped in exact imitation of the natural gum, omitting the second bicuspid, in place of which a half-tooth space is left between first bicuspid and molar, the wax gum being carried around continuously. The plaster mold of the eight front teeth is then taken, a thin septum of foil being placed opposite the mesial line, so that it may be easily broken there in the act of removal, the plaster coming slightly over the inside so as to give with certainty the shape of the cutting edges. Upon removing the front mold, and before making the lateral molds, where as yet the wax holds only two molars, it is necessary to detach the bicuspid of the front block and put it adjacent to the molar; this gives the arch its full complement of bicuspids. This must be done very neatly, so as not

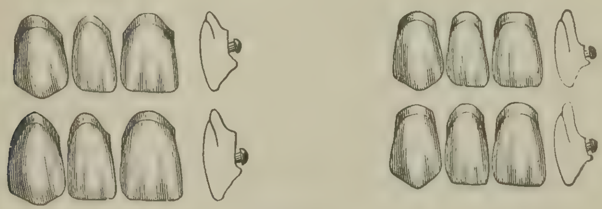


FIG. 1206.

to disturb the continuity of the wax gum, otherwise the effect of the porcelain blocks at their joints will be injured. Dr. Calvert prefers using cuspids for insertion in the wax instead of bicuspids, since their external expression is similar and their form more convenient, especially in the change just described. By similarity of form we do not mean that in any mouth the canines and bicuspids are alike externally; but out of a collection of canines, after choosing the cuspids themselves, others may be selected harmonizing with them as first and as second bicuspids. Besides overlapping the blocks at the bicuspids, to compensate shrinkage, a slight extension of each block beyond the last tooth should be made to allow for accurate grinding. If holes are made in the base, instead of platina pins in the back, it will be best to make a continuous front block of six teeth, in which case the half-tooth space above named comes behind the cuspid.

Since the carved wax of the contained teeth makes carving of the porcelain paste unnecessary, the plaster molds are varnished, oiled, and treated as are the brass molds in wholesale manufacture. The stiff

paste of point enamel is placed with a delicate spatula into each tooth matrix, thickest at the point and disappearing at the neck. The tooth enamel paste is then applied, with thickness reversed; gum enamel might also be added in the same way, but it is usually applied afterward with the brush, as this permits delicacy and uniformity of coating or easier modification of its thickness. A layer of soft body paste is now laid over the enamels, the mold is placed on the articulator, and the thickness of the block is built out and shaped in the usual way, compressing it firmly, and removing the surplus moisture with bibulous paper or the blowpipe flame. The block is next carefully removed, and while resting in its matrix the platina pins are inserted or holes drilled in the base, or dovetails cut, as may be preferred, and the whole inner surface examined and trimmed. If the inside of the block is to be finished in gum, the enamel should now be applied; then remove the block from the matrix and apply the outside gum enamel and trim between the teeth, where the thin edges of the plaster matrix are apt to be defective; the block is then ready to be dried and placed in the furnace, where it is fired at a single heat without previous biscuiting. The side blocks are made in precisely the same manner.

ENTIRE PORCELAIN PLATES.

In addition to what has already been said upon this subject, it is only necessary here to consider some of the preceding properties and manipulations of the porcelain material in its use as a plate and without any metallic support. Neither in itself, nor by known combination with any substances, can a thin porcelain plate be otherwise than frail. The fusible porcelain of the "continuous-gum work" is supported by the platina plate and the continuously soldered platina backings. Such porcelain, without metallic support, would be very frail. In endeavoring to give strength by decreasing the flux and increasing the refractory ingredients, we are at once met by the difficulty of shrinkage. Thus we encounter two horns of a dilemma—a very fusible porcelain with less contraction but great tenderness, a more refractory porcelain with greater strength but the usual one-fifth contraction, which necessarily destroys the fit of the plate if made over the unchanged model.

Dr. Allen frankly acknowledges the weakness of his very beautiful porcelain by giving it a metallic support. The dentist knows just what he is using here (see Continuous Gum), and can exercise his judgment upon the suitability of the work to any case in hand. The few dentists who make entire porcelain plates are more reserved in communicating their knowledge. Such unprofessional reserve is damaging to dentistry as a science; it would injure it also as an art if entire porcelain dentures had a strength equal to their beauty. It

is claimed by some makers of these plates that their formulas give a porcelain which is very strong, yet has a very slight shrinkage. But until such formulas are made known to the profession and an opportunity given to test them, the general prejudice against the entire porcelain base must continue to be well founded. To those desirous of experimenting in this direction we might suggest the use of silicate of magnesia and lime (asbestos) and coarsely pulverized porcelain fragments, as perhaps lessening the shrinkage of the mass.

By some the ordinary dental porcelain paste is used, making provision for shrinkage by enlargement of the model. One method of enlargement is as follows: With a fine saw divide the plaster model by a cut through the median line and another on each side; separate these four sections one-eighth inch and fill the joints with plaster, first saturating them with water; then cut the model twice at right angles to the first lines and fill with plaster as before. If the back of model is perfectly level and the work is very carefully done we shall have a tolerably accurate enlargement of about one-fifth. Make a plaster matrix over this, and into it pour a furnace model composed of three or four parts asbestos or sand to one of plaster. On this mold and carve and bake the plate and teeth; else transfer the plate to a pile of coarse silex so arranged as to give it as much support as possible during the firing.

Teeth and plate are sometimes carved out of the same mass on the enlarged model; or blocks may be made as already described, then transferred and united to a porcelain plate on this model. Sometimes the teeth from the depots are arranged in the porcelain paste and gum enamel applied around the teeth and over the plate. Unlike continuous-gum work, the teeth are not attached to any unyielding plate; hence they are liable to change position by the contraction of the plate during firing.

We cannot more appropriately close this chapter on dental porcelain than by quoting some remarks of the great English ceramic manufacturer, Josiah Wedgwood, applicable to the art which he did so much to elevate. They have a significance beyond ceramic art, and convey, in this lesson of the past, a warning to those who may, perhaps unconsciously, be dishonoring the profession of their choice.

"All works of taste must bear a price in proportion to the skill, taste, time, expense, and risk attending the invention and manufacture. Those things called dear are, when justly estimated, the cheapest; they are attended with much less profit to the artist than those which everybody calls cheap. Beautiful forms and composi-

tions are not made by chance, nor can they ever, in any material, be made at small expense. A competition for cheapness and not for excellence of workmanship is the most frequent and certain cause of the rapid decay and entire destruction of arts and manufactures."

ESOPHAGOTOMY.

As the accident of swallowing artificial dentures has occurred more or less frequently, and has in some cases resulted in death, the following case will describe the operation of removal where all efforts of a more simple nature failed to give relief:*—

"On Sunday, November 14, 1886, George K. (white), aged thirty-two years, while at dinner had the misfortune to partially swallow his set of artificial teeth, consisting of a rather narrow vulcanite plate for the upper jaw, to which were attached three incisors, one lateral incisor having been lost from the plate. The denture was arrested in its passage downward, producing intense pain and partially obstructing respiration, while deglutition, even of liquids, was rendered impossible. A physician was summoned, who detected the plate in the upper portion of the esophagus; but all efforts to remove it or force it into the stomach were futile. Sufficient opium to relieve the pain having been administered, on the following day (Monday) he was brought by his physician to the infirmary of the University of Maryland and placed under the care of Dr. L. McLane Tiffany, professor of surgery. On the same afternoon, the patient having been etherized, careful attempts to remove the plate were made, but it was so firmly impacted in the upper portion of the esophagus that all effort for its removal failed. On Tuesday, in the presence of the medical and dental classes, the patient was again etherized and efforts made to remove the plate through the mouth, but without success.

"The patient lying on his back, with his face turned to the right, so as to render the tissues of the left side of the neck tense, Prof. Tiffany made an incision about four inches in length through the integument over the depression between the trachea and the sterno-mastoid muscle. The anterior jugular vein was cut and ligated, and the incision extended from opposite the upper border of the thyroid cartilage nearly as low as the sterno-clavicular articulation. The platysma myoides muscle and the cervical fascia were then divided. The edges of the wound being held apart by retractors, the omohyoid muscle was drawn outward, and the sterno-hyoid and the sterno-thyroid muscles

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* This operation was reported for the *Dental Cosmos* and *Am. Journal of Dental Science* by Prof. F. J. S. Gorgas.

inward. The carotid sheath, with the contained vessels, was exposed and carefully drawn outward, while the thyroid gland was separated as far as necessary and drawn inward. The larynx and trachea were drawn somewhat forward, and the finger passed behind, where the foreign body could be distinctly felt through the esophageal wall.

"Care being taken to avoid the recurrent laryngeal nerve, an incision large enough to admit the finger was made into the esophagus, through which the exact position of the set of teeth was ascertained. Forceps were then introduced and the plate removed intact. The wound, after being thoroughly cleansed, was dressed with antiseptic gauze and absorbent cotton, no sutures being employed. On the following Thursday the patient was walking about his room, having a normal temperature and pulse. He was fed by means of a stomach-tube for six days, after which he was able to swallow liquid food with little or no pain, and the external wound had nearly closed."

CHAPTER XVII.

DEFECTS OF THE PALATINE ORGANS.

One of the most distressing deformities to which the human frame is liable is found in that defective condition of the palatine organs which is known to surgeons by the name of Cleft Palate. The unfortunate sufferer is compelled, in a great measure, to be an alien among his fellow creatures; an object of compassion to the considerate, he is often made painfully conscious of notice by the heartless crowd; and were he gifted with the power and eloquence of a Demosthenes or with the garrulousness of a Cleon he could make little more use of his endowments than a mute. Fortunately this painful defect is no longer to be reckoned as one of the *opprobria medicorum;* for both surgical and mechanical means are now at hand by which the imperfection may at least be remedied, and often cured.

Defects of the palatine organs may be divided into two classes, viz.: Accidental and Congenital. The first includes all loss of substance in either hard or soft palates, whether occasioned by disease or otherwise. Such defects are not uniform in locality nor in extent, consisting sometimes of simple perforations and at others involving the destruction of the velum, a considerable portion of the os palati, the vomer and turbinated bones, and the loss of a greater or less number of the teeth. The second class includes all malformations, from the simple bifurcation of

the uvula to an opening through the velum, palatine, and maxillary bones, and a fissure of the upper lip; thus uniting the nasal passages with the oral cavity throughout their entire extent.

These malformations are quite similar in character, but not uniform in extent. They may be said to begin with the uvula, and in the uvula and velum always *occupy the median line;* but as the defect progresses anteriorly, it may deflect to one side or the other of the vomer and, following the nasal passage, divide the lip, leaving the vomer articulated with the palatine bone upon one side; while in other cases the deformity seems to follow the median line, and thus involves both nasal passages, terminating in a double fissure of the lip.

Congenital defects of the palate are usually accompanied by more or less deformity of the sides of the alveolar arch and of the teeth. Sometimes the sides of the alveolar ridge are forced too far apart, and at other times they are too near each other; while the teeth are either too large or too small, and are generally of a soft texture with imperfectly developed roots.

Want of coaptation, resulting from defective formation in the palatine plates of the maxillary and palate bone, is the cause of congenital deficiencies of the parts in question. In the human embryo of about the third week the development of the *face* is clearly in progress. Five tubercles bud out from the front of the cephalic mass, of which the middle one (which is double) is directed vertically downward, and bears the appellation *incisive tubercle* because the intermaxillary bones, destined to hold the superior incisor teeth exclusively, are developed in it. On either side is the tubercle, or rudiment, of an upper maxillary bone, which is separated from its fellow by a wide interval, and from the neighboring incisive process by a fissure. The fourth and fifth tubercles, also separated in front, form by their subsequent union in the median line the inferior maxillary bone. At the same period the palate begins to be formed by the approach toward the median line of two horizontal plates, or processes, springing from the maxillary process on either side. (See Development of Bones of Head and Face.)

If now development proceed regularly and normally, the palate processes of the superior maxilla meet in the median line and unite with the blended intermaxillary tubercles, while the vomer grows downward to meet the palate processes in their line of union. The upper jaw, after the accomplishment of these changes, is complete, and the formation of the lip and primary dental groove follows in due course. But it sometimes happens that the superior maxillary and intermaxillary processes fail to unite with each other; whence we have the malformation known as *harelip*, or the palate plates are arrested in

their growth, and permanent *fissure of the palate* is the result. Consequently, the fissure of single harelip is never exactly in the median line, but on the edge of the intermaxillary bone; whereas, in double harelip, a fissure exists on each side of this bone, in which the four incisor teeth are planted.

Fissure of the hard palate is usually a little lateral, and not median, as it results from a deficiency of one or other of the palate plates of the upper maxillary bone, and it is frequently associated with harelip and fissure of the upper jaw.

FIG. 1207.

The tubercles, or formative processes of the lower jaw, advance and meet in the median line, while the upper maxillary processes are still separate. In man they are consolidated into a single piece; but they remain permanently divided in many of the lower animals by a median suture.

The principal effects resulting from an absence of a portion of the palatine organs are, an impairment of the functions of mastication, deglutition, and speech. Distinct utterance, is sometimes wholly destroyed, and mastication and deglutition are often so much embarrassed as to be performed only with great difficulty.

These effects are always in proportion to the extent of the separation or deficiency of the parts. The simple act of triturating the food may not be materially impaired by the absence of a portion—however extensive—of the palatine organs, unless the natural relations of the teeth of the upper and lower jaws are changed; still the process is more or less interfered with, as substances taken into the mouth cannot be so readily managed as when the parts are in their natural state. They are liable to escape from the control of the tongue and pass into the cavity of the nose.

In cases of congenital defects of the palate and velum it is difficult to conceive how infants manage to obtain from the breast of the mother or nurse the food necessary for their subsistence; yet, even when the anterior part of the alveolar border and part of the upper lip are wanting, the suggestions of natural instinct enable them, by a peculiar management of tongue and lip, to do it. The expedient resorted to for effecting this process is curious. The nipple, instead of being seized between the tongue, upper lip, and gum, is taken between its lower surface and the under lip and gum, and in this way it manages to extract the nourishment necessary for subsistence and growth. The tongue is thus made to close the opening in the palate and perform the office of an obturator. By contracting the lip and

depressing the tongue the milk is drawn from the breast of the mother or nurse. At this young and tender age the child is not conscious of the imperfection of its palate; and it is not until the period arrives when it should begin to make its wants known by words that it feels the importance of the function of speech, and begins to realize the misfortune with which it is afflicted.

As the child arrives at this period, the mechanism of sucking is perfected and is ultimately applied to the mastication of solid aliments. The food, when chewed, is conveyed between the tongue and movable floor (which serves for a *point d'appui*), and it is brought back between the teeth. Thus it is that the complicated operation of mastication and deglutition is performed without the alimentary morsel getting into the nose, or, if this does sometimes happen, it is the result of accident. But in cases of accidental lesion of the palate the individual has not the advantage of this training of the parts during early infancy. Those who are afflicted with accidental lesions, no matter what may be their position and extent, having acquired the habit of eating by placing the aliment upon, and not under, the tongue, can take no nourishment without a part of it getting into the nose. When to this inconvenience is added a change in the natural relation of the teeth of the two jaws, mastication is rendered still more difficult and embarrassing. When this is the case the tubercles of the teeth of one jaw, instead of being received into the depressions of those of the other, strike upon their protuberances, and cannot be made to triturate the food in as thorough and perfect a manner as is required for healthy and easy digestion. Thus not only is the process of mastication rendered imperfect, but it is also more tedious.

The process of deglutition itself, so long as the velum and uvula are perfect, is not materially affected by a simple perforation of the vault of the palate, although much difficulty may be experienced in conveying alimentary and fluid substances to the fauces and pharynx. But when this curtain is cleft, or is partially or wholly wanting, deglutition is rendered very difficult, for by the contraction of the muscles of the pharynx part of the food is forced up into the nose. The reason of this will appear obvious when we take into consideration the form and function of this movable appendage. When its muscles are relaxed it forms a slightly concave curtain; but in the act of deglutition the muscles contract, raise the velum, and close the opening from the pharynx into the posterior nares. By this valvular arrangement alimentary substances and fluids are prevented from escaping into the nose. It matters not, therefore, whether the imperfection of the velum palati be the result of accident or disease; its effects upon deglutition

are the same. In proportion as the lesion or deficiency is great will this operation be rendered difficult and embarrassing. There are cases where, in consequence of an imperfection of the palate, the patient can swallow no fluids without a part being returned by the nose. To obviate this inconvenience the head is thrown sufficiently far back to precipitate them into the esophagus. This is an expedient to which many thus affected have been compelled to resort.

Imperfection of speech always results from an opening in the palate; it gives the voice a nasal twang and renders the formation of some sounds impossible. The loss of the teeth, to a less extent, is productive of the same effect. To comprehend fully the manner in which a lesion of the palate may affect the utterance of speech, it will be necessary to understand the agency which the several parts of the mouth have in the formation of articulate sounds. Speech consists in the sounds produced by the organs of the glottis modified by the organs of the mouth. The modulation of the voice, that is, the raising or lowering of its pitch, is accomplished by the vocal cords of the glottis; but the articulation of the consonants requires the co-operation of all the movable and fixed parts of the mouth and pharynx, palate, tongue, lips, teeth, and palatine arch. Hence if any of these be defective or wanting, the power of forming some of these sounds is wholly lost, of others very much impaired; hence, also, the ability to sing is much less interfered with than the power of distinct speech. The tongue has a remarkable power of adapting itself to the loss of teeth and of some other parts, so as measurably to correct the effect on speech; but the effect of the loss of the hard or soft palate upon the voice cannot be remedied in any such way.

In both cases (accidental and congenital) the faculty of distinct articulate speech is seriously impaired by defects of any extent. In ordinary cases of congenital deformity in an adult, deglutition is not materially interfered with. The patient, having never known any other method of swallowing, is not conscious of any difficulty. Accidental lesions, however, coming generally in adult life, produce, in this respect, very great inconvenience. The remedy for these evils must be the closing of the abnormal passage by some means which will restore to the deformed organs their functions. In perforations of the hard palate, unless of extraordinary extent, the method is very simple. In the loss of the soft palate by disease the remedy is more difficult, and in extensive congenital deformity still more complicated means must be resorted to.

STAPHYLORRHAPHY.

The operation which is resorted to for closure of a cleft in the soft palate is known by the name of Staphylorrhaphy, a word of Greek

derivation, signifying suture of the uvula. It is an operation which has been successful in many instances, although there are numerous cases which will derive far more benefit from mechanism than from the surgeon's aid or a surgical velum.

To obtain success in staphylorrhaphy, the first care must be to gain a practical acquaintance with the position and relation of the muscles connected with the palate and fauces; and this can be accomplished best by laying open the pharynx from behind, for thus the posterior surface of the soft palate is at once exposed to view. This structure is wholly composed of muscular tissue covered with a layer of mucous membrane continuous with that lining the hard palate.

The muscles with which we have chiefly to do are: the palato-glossi and the palato-pharyngei, forming the anterior and the posterior pillars of the soft palate respectively; the levatores palati, the tensores palati, and the azygos uvulæ. The origin, insertion and actions of these muscles are given on page 63.

The actions of these muscles show what an important part they must bear in regard to the operation of staphylorrhaphy; and when this is considered in detail, it will be seen why but little success was met with until means were found to render muscular action of the parts impossible.

The deficiency of the palate varies considerably, from a mere division of the uvula to a gap which constitutes a hopeless deformity. When this abnormal state is limited to the soft palate, the cleft is always of a triangular shape, the apex being above and the base below; but when the soft and hard structures are involved, it is of a more or less quadrilateral shape.

We shall here only consider those cases which are congenital in their origin, merely alluding to the distinction between this class of deformity and that kind which may be said to be acquired, or is accidental. In congenital cleft the fissure is generally confined to the median line of the palate, because the two halves have not united at that part at the usual period. In acquired or accidental deformity lesions are met with in all parts of the palate, to the right or left of the median line, and are usually the result of syphilitic ulceration, or have some traumatic origin.

Congenital clefts may be thus classed: Firstly, a small, triangular-shaped fissure, extending through the uvula and the posterior portion of the velum palati, the other portion of the palate being quite intact and sound. Secondly, the whole of the soft palate is involved. Thirdly, the soft palate and a portion of the palate bone is deficient. Fourthly, the cleft may be associated with abnormality in the alveolar process of the palate bone, and even with harelip. Fifthly, openings

occur in the hard palate, the soft palate being unaffected. These separations may be very narrow, not exceeding a few lines in width, or the gap may be such that mouth and nostril seem but one.

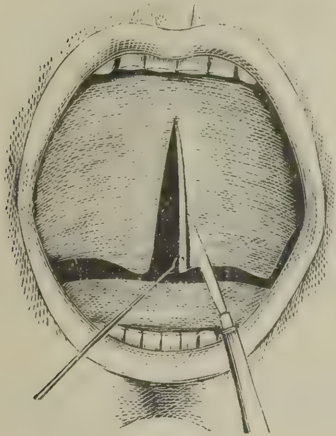

FIG. 1208.

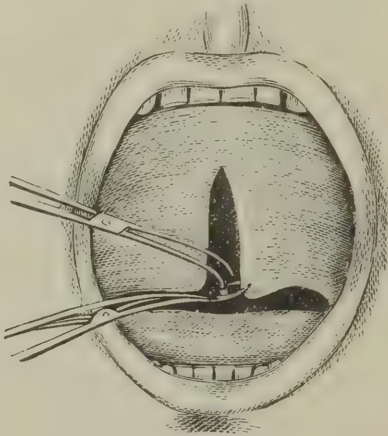

FIG. 1209.

The fissure posteriorly is *always on the median line;* anteriorly, it generally deflects to one side or the other of the nasal septum, passing also to one side of the inter-maxillary bone. In some rare cases both

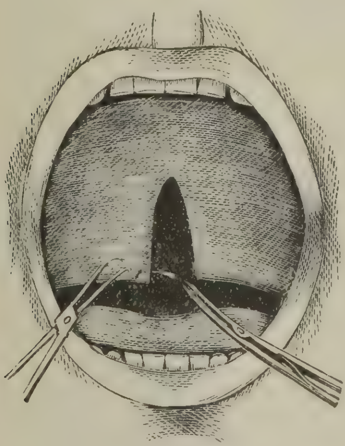

FIG. 1210.

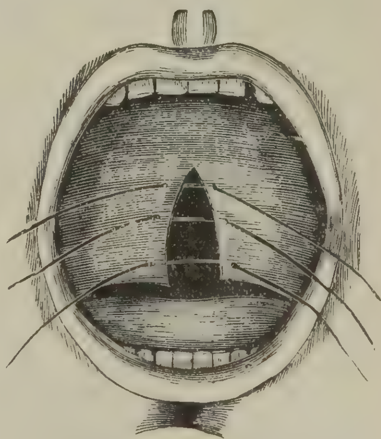

FIG. 1211.

nasal passages are involved, and a double harelip is the consequence. The effects of this condition, already stated, may thus be briefly summed up. During infancy the functions of suction and deglutition

are with difficulty performed, and at a later stage mastication and articulation are much impeded. There is also imperfect control over the muscles of the palate, both fluids and solids are liable to pass into the windpipe, and not unfrequently there is regurgitation through the nose. The speech is guttural and nasal, often so indistinct as to render it almost entirely unintelligible, and the patient is only too anxious to grasp at any chance that may be held out as being likely to grant some amelioration of his condition.

Various methods have been suggested for the cure of this deformity, such as pressure on the yielding bones in early infancy, the operation of staphylorrhaphy, and artificial substitutes; but as Dr. Kingsley remarks, the cases are very exceptional where normal articulation is ever acquired with a surgical velum—that is by staphylorrhaphy.

All the earlier operations of staphylorrhaphy consisted in paring away the edges of the cleft, and then bringing them in contact by means of sutures until union was effected. The various stages of the operation as then performed are sufficiently illustrated in the accompanying engravings, the successive steps being taken in the order of these drawings. Many modifications of this plan were made by Warren, Mettauer, Stevens, Graefe, and others; but Fergusson introduced a new principle of treatment in the operation which has very materially added to its successful results.

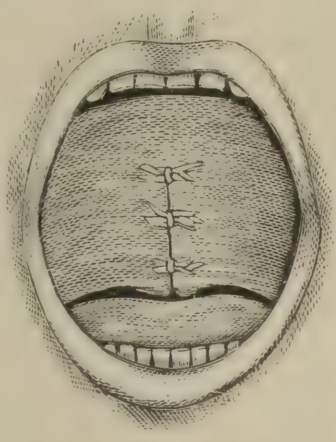

FIG. 1212.

We have alluded to the use of the muscles composing the velum of the palate and their important action on it, and to Fergusson must be assigned the credit of being the first to realize practically the fact that muscular action was the most frequent cause of failure of the operation; and he proved the truth of his conjecture by his method of removing the difficulty; namely, the division of the muscles of the palate, thus entirely paralyzing their action. Billroth more recently introduced a new procedure, which is to chisel away the lower part of the pterygoid process so as to relieve the tension produced by the tensor palati and palato-pharyngeus muscles.

Mr. Cartwright proposes the following method of treatment to prepare the patient for this operation: it has been found that the exhibition of the bromide of potassium tends to deaden the sensi-

bility of the fauces in a very remarkable manner, and thus it may become a most useful agent preparatory to the operation. If exhibited in half-dram doses, given thrice daily for two or three weeks prior to the period decided upon, but little irritability of the parts will be found remaining; and by the time a few imaginary operations on the parts have been performed, by the aid of such harmless instruments as a camel's-hair brush or the feather of a quill, the patient will be found in a fit condition to be operated upon. A few days prior to the time of operating more particular attention must be paid to the condition of the patient. Primarily, he must be well nourished, inasmuch as he will be forced to adopt a different regimen from that to which he has been accustomed for some days. His diet must be nutritious without being stimulating, and the greatest attention must be given to the regular action of the bowels, and, indeed, in all cases it is well to give a mild aperient before operating.

Sir Wm. Fergusson's Operation —Mr. Cartwright describes Mr. Fergusson's operation as follows: He first divides the muscles of the palate by passing a curved knife around between the velum palati and the end of the Eustachian tube, thus at once dividing the levator palati. In the second stage he seizes the uvula, thus bringing forward the posterior pillar of the fauces, which is snipped across with round-pointed scissors, so as to divide the fibres of the palato-pharyngeus muscle; should it be deemed necessary to do so, the anterior pillar may be divided at the same time, so as to sever the palato-glossus, though Sir William lays no stress upon the necessity of doing so. Next the uvula is again seized, with a view of extending the palate so that the edges of the fissure may be pared away; this is accomplished with a narrow bistoury from behind forward, on either side alternately, the angle of union being left for subsequent removal. A few moments then are granted to the patient to recover, and he is permitted to swallow a few small pieces of ice, with the double view of refreshing him and of staunching the bleeding. When this has sufficiently ceased, it is time to introduce the sutures, and this is done by means of a nævus needle, armed with a silken ligature (silk-worm gut is preferable for ligatures), the needle being introduced about a quarter of an inch from the edge of the fissure. Next, the extremity of the thread is pulled out by means of forceps, and another ligature is passed in like manner, until the desired number of stitches is attained. The extremities must then be tied loosely, so as just to keep the parts in apposition and no more; after which the patient is put to bed, every care being taken to avoid all motion of the palate. He should take nothing but nourishing liquid food for a few days, and must be particularly enjoined to abstain from all movements involving action of

the muscles engaged in deglutition, such, as swallowing, coughing, sneezing, and the like, which would much endanger the success of the operation. The next stage consists in the removal of the stitches; this need not be done too soon, provided they produce no irritation; indeed, they may remain until union is perfect. The general time for their removal is about the seventh or eighth day, although Fergusson often removes them on the third or fourth.

Mr. G. Pollock has introduced the following modifications in the performance of this operation: Instead of dividing the muscle with a curved knife from behind, according to the method we have just described, Mr. Pollock passes a ligature through the soft palate, so as to contract and draw it forward, and he then pushes a narrow-bladed knife through it, a little to the inner side of the hamular process of the ptergyoid plate of the sphenoid bone, which may be plainly discovered by passing the finger along the roof of the mouth to a distance a little posterior to the tuberosity of the superior maxilla. By raising the hand, and so depressing the point of the scalpel, he most effectively, and in a very simple manner, divides the muscle. The parts having healed, the patient must be impressed with the necessity of practicing himself frequently in elocution, telling him that his success in articulation will depend upon himself alone. Constant, patient, persevering effort will be necessary, and the end to be attained must be sought by distinctly articulating every syllable of every word which he may be called upon to utter. It is a good exercise to read a portion of some good author each day with a friend, who will assume the role of schoolmaster for the time being, permitting no word to be indistinctly uttered or slurred over and requiring each syllable to be correctly and separately pronounced.

Fissure of the hard palate, simple or connected with a fissure of the soft. Various means of closure have been proposed. Dr. Warren dissected the mucous membrane from the bone on either side, carrying his knife sufficiently forward toward the alveolar border to form a flap broad enough to meet a like one from the opposing side along the median line. When the fissure is so wide as to prevent the margins being brought together, Dr. Mettauer, of Virginia, recommended making several lateral incisions through the mucous membrane, with a view of permitting the edges to be brought into close apposition. Dr. Mütter, of Philadelphia, who was very successful in the operation, also had recourse to the longitudinal incision (as shown by Fig. 1213), which was first proposed by Dieffenbach, with happy results. Dr. Warren's operation has been introduced into England by Mr. Pollock, who, with his peculiarly constructed instruments, proceeds as follows: He makes an incision along the edge of the cleft at the juncture of the

nasal and palatal mucous membrane. The soft covering of the hard palate is carefully dissected or scraped from the bone with curved knives, great care being taken that the mucous membrane and its subjacent fibrocellular tissue are not perforated. When this has been well loosened on either side, it will be found to hang down like a curtain from the vault of the mouth, the two parts coming into apposition along the median line, or possibly overlapping. The edges, being then smoothly pared, are brought together by means of a few points of suture introduced in the ordinary way and without any dragging. Where the hole is not very large, Dr. Pancoast's operation of staphyloplasty may be performed, in which he raises two flaps of mucous membrane from the bone on either side, and then, reflecting them across the chasm, their edges are brought together by suture in

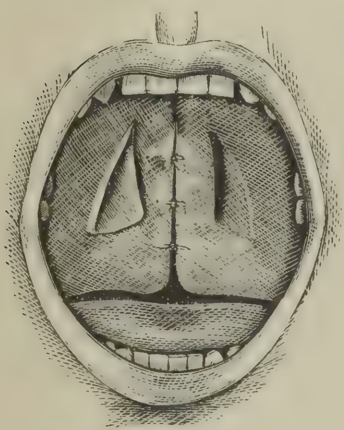

FIG. 1213.

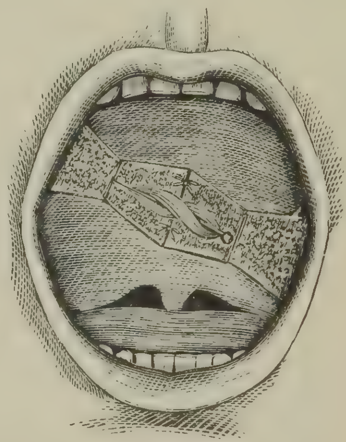

FIG. 1214.

the usual manner, a plan which is so perfectly exhibited in Fig. 1214 that we do not deem any further description necessary. M. Langenbeck suggested another operation, in which he proposed to dissect the mucous membrane, together with the periosteum, from the surface of the bone prior to bringing the opposed surfaces of the cleft in apposition; and the advantages claimed by him for this, which he considers to be a novel method of procedure, is that the chasm is obliterated, not merely by soft tissue, but by bone, which is formed from the periosteum thus loosened from contact with the surface of the hard palate. Dr. T. W. Brophy has recently suggested the following operation: "Vivify the edges of the fissure thoroughly and with a bold hand. On the hard palate trim the opposing surfaces of the bone as well; the knife will easily cut through the soft bone of the hard palate and

the alveolar process. The fissure is then brought together by wire sutures passing through a lead button and the body of the maxilla above the palatal bone, then tightened by twisting until the parts are in contact. In some cases the maxillæ are divided horizontally beneath the malar process. If the resistance is such that the edges do not readily approximate, the malar process is divided on either side by the aid of a heavy scalpel."

There are many cases of abnormality in the os palati which can only be relieved by mechanical appliances, and this relief can be afforded in a most satisfactory manner, no more inconvenience being felt by the patient than he would experience in wearing an artificial denture, with which the false palate could be connected, were it necessary to do so. Artificial aid has been several times alluded to in reference to the operation of staphylorrhapy; but it is now a well established fact, that in the large majority of cases a scientifically constructed artificial velum will prove satisfactory. The main and only object is to give to the afflicted the power of articulate speech, and this, as Dr. Kingsley remarks, can only be produced normally by voluntarily opening and closing the passage from the larynx to the nose. If this cannot be accomplished, because of the inability of the palate to act, speech will be defective. Undoubtedly, the operations which have been described are often, as far as mere union is concerned, most satisfactory in their results; but there are other considerations besides these. Naturally the chief desire of the patient is to take a footing in society on equal terms with other men; and there are no means which will enable him to do so, unless they can restore to him his lost or impaired power of speech—that divine gift which places man so immeasurably above the brute creation. This has been almost lost in many cases of cleft palate; and it is the great object of treatment to put the sufferer in a way of uttering his thoughts in plainly-spoken words like those around him; whatever means are best calculated to bestow this inestimable benefit are those which the conscientious surgeon ought to select.

There are certain cases where the opening is not large, and as there is little tension of the parts the opposite sides come together in close proximity; staphylorrhaphy may here be performed with good results, for it must be recollected that it is always a desideratum to avoid the presence of foreign substance as a substitute for natural tissues, if these are equally effective. Allusion has been made to the liability to injury of the parts by a division of the muscles. Where an artificial palate is used the muscles are unimpaired; and it is claimed that persons who when without the instrument could not be understood, spoke fluently and distinctly the

moment they introduced it into their mouths. So far as the discomforts of wearing such an apparatus are concerned, after a short time the wearers become entirely unconscious that they are wearing anything artificial.

OBTURATORS AND ARTIFICIAL PALATES.

We have classified palatine defects as accidental and congenital; we shall also classify the appliances used for their remedy. The term *obturator* will be used for all instruments intended to stop or cover all those openings in the hard or soft palate which have a well defined border or outline. The term *artificial velum* is applied to a mechanical contrivance which consists of an elastic, movable valve which is under the control of adjacent or surrounding muscles and capable of closing or opening the posterior nares at will, and which is applicable to cases of congenital cleft-palate, and also in certain cases, when the soft palate has been destroyed by ulceration.

Any unnatural opening between the oral and nasal cavities which will permit the free passage of the breath will impair articulation. Any appliance which will close such passage and can be worn without inconvenience will restore articulation.* Obturators were formerly made of metallic plate, gold or silver being most commonly employed, and many very ingenious pieces of mechanism were the result of such efforts; but latterly vulcanized rubber has almost entirely superseded the use of metals. Vulcanite has been found preferable to metals, being much lighter and much more easily formed and adapted, particularly when of peculiar shape. In regard to the age of the patient which is most suitable for the application of an artificial velum, Dr. Kingsley remarks that for some thirty years past he has been applying such contrivances repeatedly for children under ten years of age.

Bourdet was the first who proposed to employ simply a metallic plate fitted to the vault of the palate and large enough to cover the opening, with two lateral prolongations, one on each side, extending to the teeth, to which they are fastened by means of ligatures. This was also found to be objectionable, as the ligatures were productive of constant irritation to the gums; moreover, they did not hold the plate in place with sufficient stability, and its use was soon abandoned. But these objections were both obviated by an improvement made by M. Dela-

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* The student will bear in mind that no cognizance is here taken of openings similar to those described in cases of congenital fissure, where the surgeon has united the soft palate, and left an opening through the hard palate to be covered by an obturator.

barre, which consisted in the employment of clasps, instead of ligatures, attached to lateral branches of the plate. To prevent these from slipping too high up on the teeth he attaches to each a kind of spur, which was so bent as to come down over the grinding surface of the tooth to which it is applied. The last-named author also made another modification, which consisted in the application of a drum to the upper surface of the plate (Fig. 1215). The object of this was to prevent the accumulation of mucous fluids from the nose in the *cul-de-sac*, formed by simply closing the opening below; also to prevent fluids, in swallowing, from passing up between the obturator and the soft parts through the opening into the nose. The drum evidently offers the same impediment to nature's efforts in closing the opening as the obturator before mentioned; on this score, therefore, it is equally objectionable.

When the opening in the palate is small, and has *no connection with the velum*, it is unnecessary to raise the upper surface of the plate by

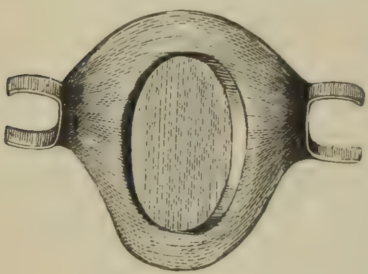

FIG. 1215.

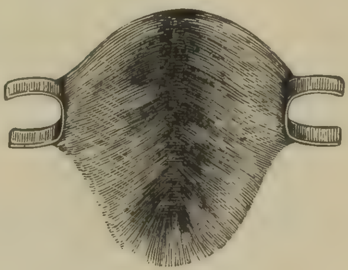

FIG. 1216.

attaching a drum or air chamber to it. If it be accurately fitted to the vault of the palate, it will effectually prevent fluids, in deglutition, from passing up in the nasal cavities, or the escape of any portion of the voice through the opening; also by frequently removing the plate the accumulation of the secretions in the *cul-de-sac* will be prevented. A simple plate, like the one represented in Fig. 1216, will be all that is required to remedy the defect; and this, in fact, will probably be found the best form in all cases, whether the openings be large or small.

Fig. 1217 represents an obturator without teeth and without clasps for a perforation of the hard palate, being sustained *in situ* by impinging upon the natural teeth with which it comes in contact. Accuracy of adaptation and delicacy in form are all that is essential in such cases, and the restoration of the speech will follow immediately.

A clumsy contrivance will interfere with articulation almost as much

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as it is improved by stopping the opening; therefore, if the obturator could be confined entirely to the opening, like a cork in a bottle, it would be more desirable. As this cannot be, resort must be had to clasping the contiguous teeth, if there are any; if there are none, the obturator must extend over the whole jaw and receive its support in the same manner as would a set of artificial teeth. In fact, this is precisely what it becomes in such a case—an upper set of teeth bridging over and filling up an opening in the palate, thus combining an obturator, with a denture. Fig. 1218 represents a more complicated obturator, adapted to an opening in the soft palate. The necessity for a variation in the plan will be found in the anatomical fact of the constant muscular action of the soft palate, which would not permit, without irritation, the presence of an immovable fixture. This is contrived, therefore, with a joint, which will permit the part attached to the teeth to remain stationary, while the obturator proper is carried up or down as moved by the muscles. The joint, A, should occupy the

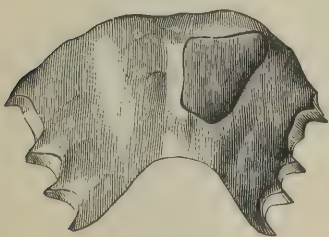

FIG. 1217.

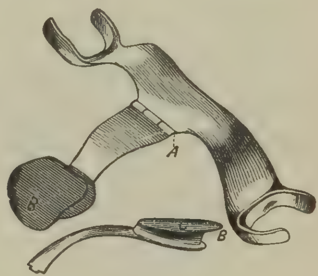

FIG. 1218.

position of the junction of the hard and soft palates. The joint and principal part of the appliance is made of gold, the obturator of vulcanite. The projection, B, lies like a flange upon the superior surface of the palate and sustains it; otherwise the mobility of the joint would allow it to drop out of the opening. This flange is better seen in the side view, marked C. It is readily placed in position by entering the obturator first, and carrying the clasps to the teeth subsequently.

Figs. 1217 and 1218 will illustrate the essential principles involved in all obturators. The ingenuity of the dentist will often be taxed in their application, as the cases requiring such appliances all vary in form and magnitude. The steps to be taken in the formation of an obturator are not unlike those used in making a base for artificial teeth. It is essential that an accurate model be obtained of the opening, the adjacent palatal surface, and the teeth, if any remain in the jaw. For this purpose an impression taken in plaster is the only kind to be relied upon. Care must be used that a surplus of plaster is not forced

through the opening, thus preventing the withdrawal of the impression by an accumulated and hardened mass larger than the opening through which it passed. To avoid this, beginners or timid operators had better take an impression in the usual manner with wax. If this is forced through, it can be easily removed without injury to the patient. From this wax impression make a plaster model, and upon this plaster model form an impression cup of sheet gutta-percha, using a stick, a piece of wire, strip of metal, or any other convenient thing for a handle. This extemporized impression cup must not impinge upon the borders of the opening, neither should it enter to any extent. With a uniform film of soft plaster, of from one-sixteenth to one-eighth of an inch in thickness, laid over this cup a correct impression can be taken without any surplus to give anxiety. Upon a correct plaster model taken from such an impression the obturator should be molded out of gutta-percha or any other plastic substance, the subsequent steps being in principle the same as in making any other piece of vulcanite. It is desirable that it should enter the perforation and restore, as far as possible, the lost portion of the palate; but it must not intrude into, or in any way obstruct, the nasal passage. *The entire freedom of the nasal passage is essential to the purity of articulation.* That portion of the obturator which occupies the oral cavity should be made as delicate as possible, consistent with its strength and durability.

ARTIFICIAL PALATES.

Before proceeding to a description of artificial palates, a brief reference to the anatomical relations and functions of the *velum palati* will be necessary. The palate exercises quite as important an office in the articulation of the voice as does the tongue or lips. Being a muscular and movable partition to separate the nasal and oral cavities, one edge is attached to the border of the hard palate, while the other vibrates between the pharynx and the tongue. The voice, therefore, as it issues from the larynx, is directed by the palate entirely into the mouth or through the nose, or permitted to pass both ways.

A very slight deviation in this organ from its natural form will make the voice give a different sound; so the presence of anything that clogs the natural passages, either oral or nasal, modifies the vocal vibrations. Place any obstruction in the nasal passages, paralyze the soft palate, or let it be deficient in size, and the power of distinct articulation is wanting. Evidence of this statement is very frequently found after the surgeon has successfully performed the operation of staphylorrhaphy in case of congenital fissure. In such instances (with rare exceptions) the newly-formed palate is so deficient in length and so tense as to be deprived of its function. It cannot be raised so as

to meet the pharynx and shut off the nasal passage, but hangs like an immovable septum to divide the column of sound.

Fig. 1219 represents a defective palate belonging to the first class, the uvula and a portion of the contiguous soft palate being destroyed by disease. In such a case an obturator would be useless; the constant activity of the surrounding parts would not tolerate it. The material used for a substitute must be soft, flexible, and elastic; and the elastic vulcanite is admirably adapted to this purpose.

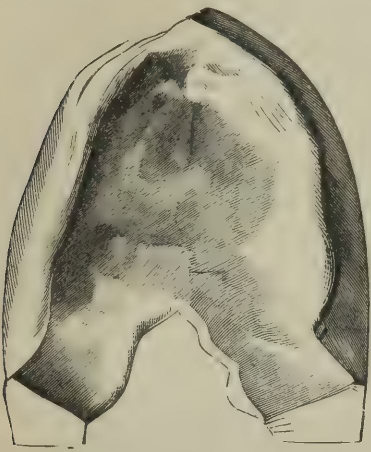

Fig. 1219.

By observing the cut (Fig. 1219), it will be seen that a portion of the soft palate along the median line remains, and consequently there will be considerble muscular movement which must be provided for and which may be taken advantage of. It is desirable to make this movement available in using an artificial palate, as thereby more delicate sounds are produced than otherwise.

This case presented some extraordinary difficulties in the fact that all the teeth of the upper jaw had been extracted; and it was necessary, therefore, to adapt a plate which should not only sustain the teeth for mastication, but bear the additional responsibility of supporting the artificial palate. In the choice of material best adapted as a base for the teeth in such instances, it is preferable to adopt that which will prove the most durable. There are too many interests involved to risk the adoption of anything but the best. In the case under description the patient desired duplicates, and two sets of teeth were made, one on gold and the other on platina, with continuous gum. The plates were made like other sets of teeth, with the exception of a groove located on the median line at the posterior edge to receive the attachment for the palate (marked C in Fig. 1220).

Fig. 1220 will indicate the set of teeth with palate attached. The wings, marked A and B, are made of soft rubber; the frame to support them is made of gold, with a joint to provide for the perpendicular motion of the natural palate, as in the case of the obturator represented in Fig. 1218. When the artificial palate is in use, the joint and frame immediately contiguous lie close to the roof of the mouth; the rubber wing, letter A, bridges across the opening on the inferior

surface of side next the tongue; the wing, letter B, bridges across the opening on the superior or nasal surface, and is also prolonged backward until it nearly touches the muscles of the pharynx when they are in repose.

Both these wings reach beyond the boundary of the opening and rest on the surface of the soft palate for a distance of from one-eighth to one-quarter of an inch, thus embracing the entire free edge of the

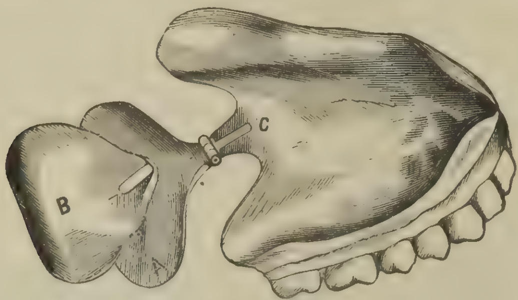

FIG. 1220.

soft palate. This last provision enables the natural palate to carry the artificial palate up or down, as articulation may require.

When the organs of speech are in repose there is an opening behind the palate sufficient for respiration through the nares. When these organs are in action, a slight elevation of the palate or a contraction of the pharynx will entirely close the nasal passage and direct all the voice through the mouth. The palate thus becomes a valve to open or close the nares, and to be tolerated must be made with thin, delicate edges which will yield upon pressure. An instrument thus made will restore, as far as possible by mechanism, the functions of the natural organ.

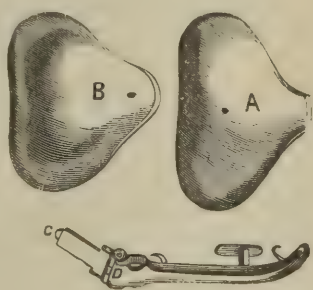

FIG. 1221.

Fig. 1221 represents the artificial palate separated into its constituent parts. The frame is bent at the joint in the engraving to show a stop marked D, which prevents the appliance from dropping out of position. Letter C shows the tongue, which enters the groove in the plate of teeth and connects them. Letters A and B are the rubber flaps, which are secured to the frame by the hooks, as seen in the engraving. The process for making rubber wings will be found described on page 1155.

Fig. 1222 shows a more extensive palatine defect of the first class.

In this case the entire soft palate is gone, together with a small portion of the hard palate at the median line. Although this defect is greater in extent, the means for its remedy are more simple. The muscles of the palate are entirely gone, and, consequently, no perpendicular movement need be provided for. The appliance in this case will resemble an elastic obturator more than the valve-like palate of the preceding one. The principle here adopted is substantially that recommended by Mr. Sercombe, of London, some years since, and consists of a plate with a set of teeth in the usual form, and attached to its posterior edge an apron of soft rubber, which shall bridge the opening on its inferior surface, extending nearly to the pharynx. Fig. 1223 represents the set of teeth with the palate attached. In Mr.

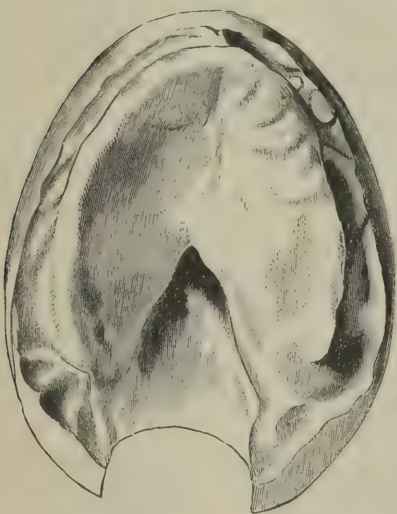

Fig. 1222.

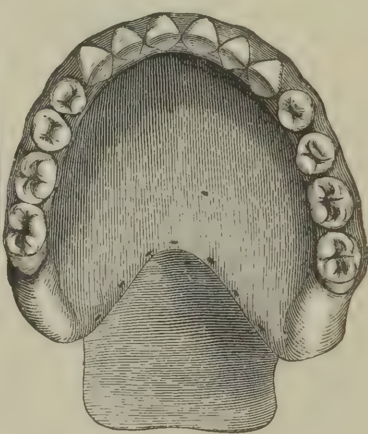

Fig. 1223.

Sercombe's appliance this apron was made of the common sheet rubber in the market, prepared for other uses, and is objectionable for two reasons: 1st. A want of purity in the materials of which it is compounded, in many instances substances being used in its manufacture which would prove deleterious to the health of the patient; and, 2, its uniformity of thickness. It is far preferable, therefore, to make a mold from which to form a palate of pure and harmless materials, one which shall be of sufficient thickness in the central part and at its anterior edge to give stability, and yet shall have a thin and delicate boundary wherever it comes in contact with movable tissue. Such a palate may be made in a mold by substantially the same process as hereafter described. (See page 1155.) It may be

secured to the plate by a variety of simple means. One, which will give as little trouble to the patient as any other, is to make a series of small holes along the edge of the plate and stitch it on with silk, or fine platina, gold, or silver wire may be used. It is desirable in this case to have the plate and palate present a uniform surface on the lingual side. In fitting the plate, therefore, it may be raised along the posterior edge from the sixteenth to the tenth of an inch, according to the thickness of the palate desired. The rubber will thus be placed on the palatine surface of the plate and present uniformity on the lingual surface.

A little thought will show that in this case the patient must educate the *muscles of the pharynx alone* to do the work of shutting off the nares, which, in the former case, was performed by them in conjunction with the muscles of the palate. Perfection of articulation will, therefore, depend upon the success of the patient in this new use of these muscles.

In cases of accidental lesions of the palate, such as are under consideration, this education of the muscles to a new work will not be difficult. The patient at some former time has had the power of distinct articulation; his ear has recognized in his own voice the contrast between his present and former condition; the ear will therefore direct and criticize the practice until the result is attained.

In the case illustrated by Fig. 1222, the defect had existed for twenty-eight years, the patient, at the time of the introduction of the artificial palate, being nearly fifty years of age. The effect upon the speech was instantaneous. Articulation was immediately almost as distinct as in youth; and this remarkable distinctness can only be accounted for upon the assumption that the pharyngeal muscles had undergone a thorough training in the vain effort to articulate without any palate.*

These two cases, chosen to illustrate the application of artificial palates in accidental lesion, have required, as will have been perceived, entire upper sets of artificial teeth in connection with the palates. This selection was purposely made because the difficulties to be overcome are much greater. In cases where there are natural teeth remaining in the upper jaw, the palate and its connection with a plate would be substantially the same, and the plate might easily be secured to the teeth by clasps, in the same manner as a partial denture.

Artificial Palates for Congenital Fissure.—Congenital fissure of the

* An account of this case appeared in the *Argus*, of Bainbridge, Georgia, August 1st, 1868, written by the patient himself, who was the editor of that paper.

palate presents far greater difficulties to be overcome than cases of accidental lesion. The opening is commonly more extensive, the appliance more complicated, and the result more problematical. Nevertheless, appliances have been made in a large number of cases which have enabled the wearers to articulate with entire distinctness, so much so as not in the least to betray the defect.

The first efforts made in this direction resembled obturators. They were simply plugs to close the posterior nares, and the results were far from satisfactory. It was not until it was recognized that the two classes of cases, accidental and congenital, were entirely distinct, that much progress was made.

Nearly every case of accidental lesion can be treated by an obturator with considerable success; but very rarely will an obturator be of any benefit in congenital fissure, even if the congenital and accidental cases present substantially the same form of opening. For this reason much embarrassment has been thrown around these appliances within a few years past. *The character of the different classes has been confounded, and an instrument admirably adapted to one class has had claimed for it an equal application to the other class.* Let it be understood, therefore, as a rule to which there will be but few exceptions, *that congenital fissure of the soft palate requires for its successful remedy a soft, elastic, and movable appliance;* and that, with the most skillfully made instrument, *vocal articulation must be learned* like any other accomplishment. Various inventions have been made for this purpose within the last twenty-five years, from the most complicated one of Mr. Stearns, described in a former edition of this work, to the extremely simple one of bridging the gap with a single flap of rubber. The Stearns instrument, with all its complexity, embodied the only true principle, viz., *rendering available the muscles of the natural palate to control the movements of the artificial palate.*

The essential requisites of an artificial palate are (1) to replace, as far as possible, the natural form of the defective organs (2) with such material as shall restore their functions. Muscular power certainly cannot be given to a piece of mechanism, but the material and form may be such that it will yield to, and be under the control of, the muscles surrounding it, and thus measurably bestow upon it the function of the organ which it represents.

Fig. 1224 represents a model of a fissured palate, complicated with harelip on the left of the median line. There is a division also of the maxilla and alveolar process; the sides, being covered with mucous membrane, lie in contact with each other, but they are not united. If it is desired, a very simple surgical operation can be performed which will unite both soft and hard tissues at this point of division.

The left lateral incisor and left canine tooth are not developed. Fig. 1225 represents the artificial velum as viewed upon its superior surface, together with the attachment of a plate containing a clasp and two artificial teeth to fill the vacancy.

The lettered portion of this appliance is made of elastic vulcanized rubber; its attachment to the teeth, of hard vulcanized rubber, to

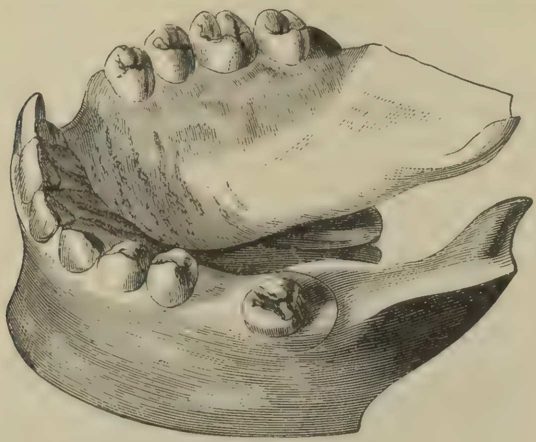

FIG. 1224.

which the velum is connected by a stout gold pin, firmly imbedded at one end in the hard rubber plate. The other end has a head, marked C, which, being considerably larger than the pin and than the corresponding hole in the velum, it is forced through—the elasticity of the velum permitting—and the two are securely connected. The process

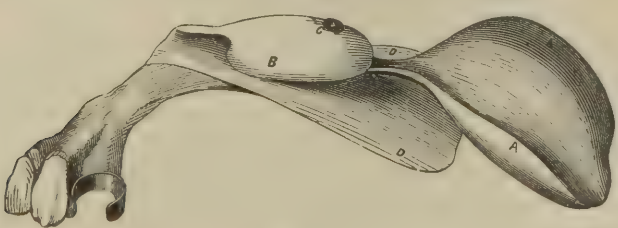

FIG. 1225.

B laps over the superior surface of the maxilla (the floor of the nares) and effectually prevents all inclination to droop. The wings, A, A, reach across the pharynx, at the base of the chamber of the pharynx, behind the remnant of the natural velum. The wings, D, D, rest upon the opposite or anterior surface of the soft palate.

Fig. 1226 represents a model the same as Fig. 1224, with the appliance, Fig. 1225, *in situ;* the wing, D, D, in Fig. 1225, and the posterior end of the artificial velum, A, alone being visible in this figure.

The reader will bear in mind that the essential characteristics of this appliance are a soft, elastic substance filling the gap in the soft palate, with a flap behind as well as before, which enables it to follow all movements of the muscles with which it comes in contact, and thus perform, to a very considerable degree, the function of the fully developed natural organ.

It is this characteristic alone which made the Stearns palate a success, and to produce which result Stearns invented the complicated and, for most cases impracticable, machinery as shown in Figs. 1233

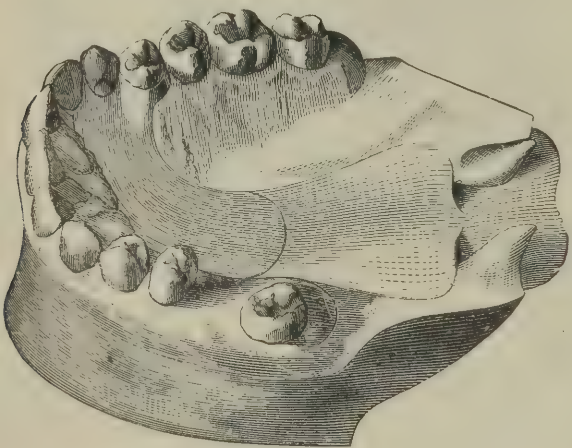

FIG. 1226.

and 1234. It was to produce the same effect by a simple appliance that the writer labored unremittingly for more than ten years, the appliance of to-day being no modification in any sense of the Stearns instrument, nor of that of any other author, but an individual and separate invention, so very simple that we can conceive of no different way by which perfection of result can be so nearly attained. A hundred instruments of like character now being successfully worn attest the writer's confidence in it. Simplicity has gone but one step further, and that has been to leave off entirely the posterior flap marked A, A in Fig. 1225. This has been done in England, France, and Germany, and occasionally in our own country, and a parade made of the fact, as an improvement on the inventions of the writer; but the experience of the past shows that in all these cases the makers have failed to com-

prehend the requirements of the case, and have, in attempting to improve the instrument, dispensed with one of its essential characteristics.

A later invention, and one which the author believes to be of almost universal application, is represented in Fig. 1227. To appreciate the importance of this invention it must be borne in mind that heretofore an instrument peculiar in form has been required for every separate case. Each appliance, being made in a mold of special adaptation, has therefore entailed upon the operator a large amount of labor.

With this later invention it is believed that with a few molds, producing a limited variety of palates adapted to the leading features in such cases, nearly every case of congenital cleft can be provided for upon the same principle as other forms of surgical appliance are made for general use. It was only after years of experience and the obser-

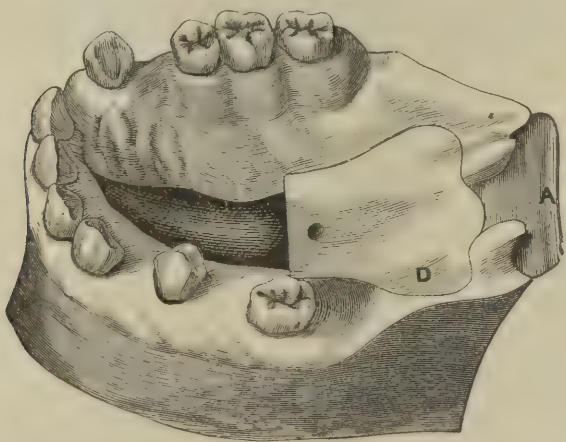

FIG. 1227.

vation of many cases that the characteristics which were common to all could be determined.

Those common features are: (*a*) The fissure through the soft palate is always in the median line; (*b*) the variations, if any, from the median line are anterior to the soft palate in the palatine and maxillary bones; (*c*) thickness of the border of the fissure in the remnant of the soft palate is generally uniform; (*d*) the sides correspond very nearly with each other in length, breadth, thickness, and contour; (*e*) the chief variation in nearly all clefts of the soft palate is in their size or breadth, and this is true without any reference as to whether the fissure extends forward into the hard palate or not. Figs. 1224 and 1227 represent two cases of remarkable general likeness, although

they differ twenty years in age and more than five years in the period of time at which they were treated.

The palate placed *in situ* in Fig. 1227 shows an instrument which, with variations in size, is of almost universal application. It is nearly identical with the palate, Figs. 1225 and 1226, were that one cut across the middle. Like the other, it is made of soft rubber, and, moreover, it will need an additional fixture to fill the gap in the hard palate and also keep the artificial velum from being swallowed. In Fig. 1225 there is a projection marked B, which is made of soft rubber and is a part of the velum. This projection, as has already been noticed, is intended to assist in supporting the velum in position. This is not always necessary or desirable; there are cases where the velum is quite as well sustained without this projection, and where, if it were applied, it would certainly injure the tone of the voice by clogging the nasal passage. In the case of Fig. 1227, if support were desired by lapping on the floor of the nares, toward the apex of the fissure, it would form a portion of the hard palate or obturator instead of being part of the velum or soft palate as heretofore.

OBTURATORS AND PALATES COMBINED.

We shall proceed now to consider another class of cases, the proper treatment of which has been followed by the most encouraging results.

For fifty years the operation of staphylorraphy has been a favorite one with surgeons, yet the number of cases in which there has been only a partial union are largely in the majority. In many instances all that has been accomplished is simply the tying together of a small portion of the soft palate across the back part of the fissure, leaving an opening of greater or less size through the hard palate, anterior to the newly formed septum. This opening has generally been plugged with an obturator, but vocal articulation has been little, if at all, improved. To meet this emergency a new form of artificial velum was invented. Fig. 1228 will illustrate such a case with the obturator and artificial palate *in situ*.

The patient was a man fifty years of age. The operation of staphylorraphy had been performed twenty years previously; an obturator of silver, and afterward one of vulcanite, has been worn constantly ever since. Nevertheless, the articulation was not benefited, the reason being the same as in every other case of staphylorraphic operation, the new fleshy palate, marked A, not being long enough to close by any muscular effort the passage to the nares. There was, however, some remaining muscular action, to utilize which power was the desired object to be attained. Letter B, shows the obturator, the letter C, the velum. In this instance the obtu-

rator is made of soft rubber, the same as the velum, and when in use the velum is but an extension of the natural palate, as seen in Fig. 1228.

Fig. 1229 shows the appliance when not in use. The plate, D, secures the obturator to the teeth, as in other cases of artificial palates. In order to introduce the piece, the broad flap, C, should be first passed through the opening in the roof and pushed back; the

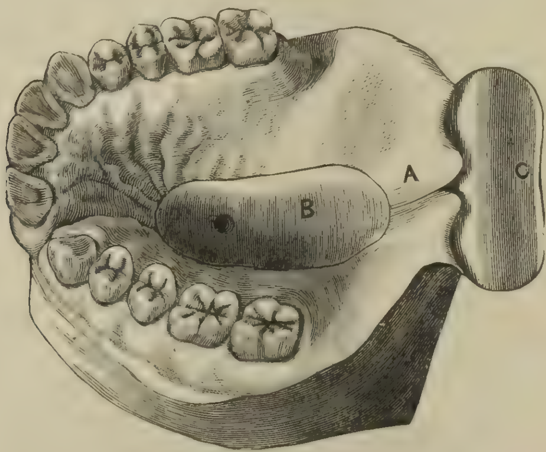

FIG. 1228.

whole fixture will readily fall into correct position. In the case of this patient, the improvement in vocal articulation was immediate and very decided.

Fig. 1230 illustrates another case of a similar character, but with incidental circumstances much more interesting. The patient was a lady, sixty-two years of age, for whom staphylorraphy was performed in 1845, by a distinguished surgeon, and the result was a remarkable success, so far as the union of the parts was concerned. The union was perfect throughout the entire length of the fissure, including the uvula; but although the patient had applied herself diligently to

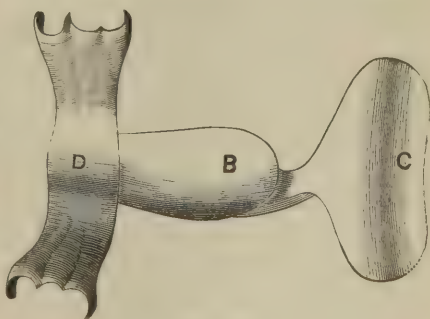

FIG. 1229.

the improvement of her speech, she was unsatisfied with her progress. The fault being the same as in all other cases—too short a palate—

the remedy must be the same. But here arose another difficulty. There was no opening through the roof of the mouth, as in case of Fig. 1227, and there was no method of securing the desired palate extension to the inferior surface of the natural palate. To convey to the artificial velum the action of the levatores palati was essential to success. After consultation with a skillful and distinguished surgeon of this city (Dr. George A. Peters, New York), it was decided to undo, in a measure, the operation of twenty-five years before, and an opening was made through the soft palate on the median line immediately behind the hard palate, as shown in Fig. 1230. The opening was a simple straight incision, which was subsequently enlarged by wearing a tent for a short time. There was no

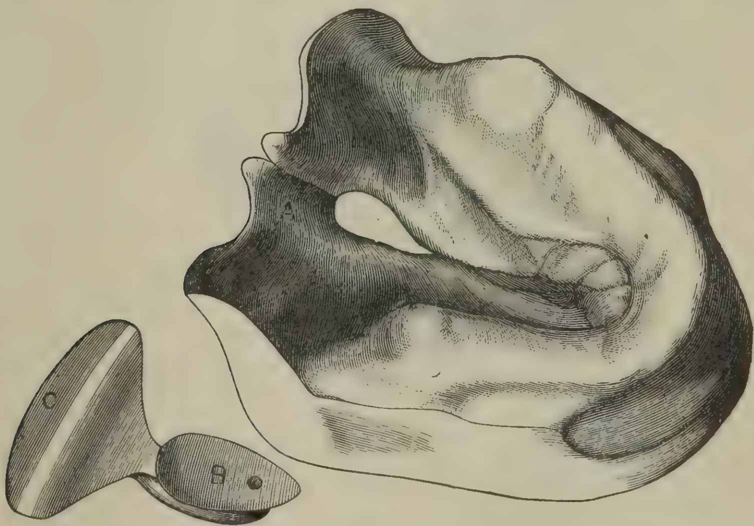

FIG. 1230.

pain; but little bleeding; and in a few days it was entirely healed. What complicated the case still further was the loss of all the teeth in the upper jaw, and an entire upper denture had been worn for years. The artificial palate was attached to such a denture, and, instead of proving detrimental to the denture, it was an advantage, serving, when in place, to keep the back edge of the plate from the possibility of dropping. The marked improvement in articulation and the gratification of the patient were a sufficient justification for the partial undoing of such an admirable surgical operation.

The later experience of the writer favors the idea of a partial staphylorraphic operation, with a view of making a narrow bridge across the posterior part of the fissure. Even the tying of the bifurcated

uvula together would be of far more service to the patient than a union throughout the length of the cleft. Such a slight bridge of the gap is more easily and certainly obtained than when greater attempts are made; as the surgical operation can be supplemented by an artificial velum of a very simple character, the patient thus derives the highest benefit which surgical skill can at this day give.

Method of Making an Artificial Palate.—The success of these appliances depends very much upon the perfect accuracy of the model, since it is upon this that the parts are molded. It is essential that the entire border of the fissure, from the apex to the uvula, should be perfectly represented in the model, as these parts are when in repose. It is also necessary that the model show definitely the form of the cavity above, and on either side of, the opening through the hard palate, since that part of the cavity is hidden from the eye. It is desirable, although it is not essential, that the posterior surface of the remnant of the soft palate be shown; but it is especially important that the anterior or under surface be represented with relaxed muscles, and in perfect repose. The impression for such a model must be taken in plaster; it is the only material now in use adapted to the purpose. An ordinary britannia impression cup may be used, selecting one corresponding in size and form to the general contour of the jaw. This cup will be found too short at the posterior edge to receive the soft palate, but it may be extended by the addition of a piece of sheet gutta-percha, which must be molded into such form as not to impinge upon the soft palate, but which will reach under and beyond the uvula, and thus protect the throat from any droppings of plaster. Before using the plaster, the posterior edge of the gutta-percha extension may be softened by heat and introduced into the mouth. Contact with the soft palate will cause it to yield, so that there is no danger of its forcing away the soft tissues when the plaster is used. The first effort will be to get only the lingual surface, taking precaution not to use too much plaster. After trial, if the impression show definitely the entire border of the fissure, and the soft palate has not been pushed up by the spasmodic action of the levator muscles, it is all that is thus far desired. If, however, the soft parts have been disturbed (which, on close comparison, a little experience will decide), it is better to take a model from the impression; and from this model extemporize an impression cup, as described on page 1139. This temporary cup will have the advantage of the former, inasmuch as it requires but a thin film of plaster to accomplish the result, thus lessening the danger of disturbing the soft tissues. After the removal, if it is seen that any surplus has projected through the fissure and spread out over the floor of the nares, it should be trimmed off.

In most cases such an impression will be all that is required. Such an impression can be taken, with a little experience, quite as readily as a correct impression for a set of teeth. The all-important point is to have the border of the fissure closely defined, with the soft parts hanging in their *relaxed condition.* It is not essential to one of experience that the pharynx behind the uvula should be taken in the impression. When the model is obtained from the impression, a representation of the pharynx can be made, with sufficient accuracy for practical purposes, by carving. It is only when the floor of the nares is used for the support of the palate that it becomes necessary to obtain a more complicated impression, one which shall represent not only a portion of the buccal cavity, but all the superjacent nasal cavity. When this is required, the next step will be to obtain, in conjunction with this impression of the under surface (which we call the palatal impression), an impression of the upper or nasal surface of the hard palate. This can be done by filling the cavity above the roof of the mouth with soft plaster down to the border of the fissure, and while yet very soft, immediately carrying the palatal impression against it and retaining it in that position until the plaster is hard, which can be easily ascertained by the remains in the vessel from which it was taken. Taking the precaution to paint the surface of the palatal impression with a solution of soap, to prevent the two masses from adhering when brought in contact, there will be no difficulty in removing it from the mouth, leaving the mass which forms the nasal portion *in situ.* With a suitable pair of tweezers this mass is easily carried backward and withdrawn from the mouth; the irregular surface of contact indicates its relation to its fellow when brought together.

Fig. 1231 will show such an impression. The portion marked A, B, C will readily be distinguished as that which entered the nasal cavity. The line of separation from the palatal impression is plainly indicated in the engraving. The groove marked D shows clearly the impression made by the delicate uvula in the soft plaster. The nasal portion is relatively large, showing an unusually large nasal cavity. The vomer lies between the projections marked A, A, these projections entering the nasal passages. The surfaces marked B, B, come in contact with the middle turbinated bones; the surface marked C, in contact with the inferior

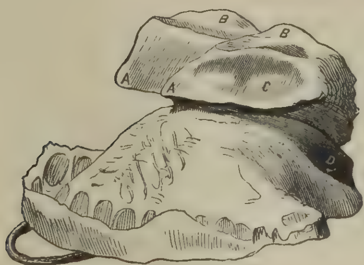

FIG. 1231.

turbinated bone. In many instances these turbinated bones are so large as to nearly to fill the nasal passages.

The method of obtaining a model of the mouth from this impression does not require any particular description. The process is similar to the making of a cast into any other mouth impression. The model represented in Fig. 1230 shows a convenient form for such a case.

When the nasal portion of the impression does not indicate the superior surface of the soft palate, the part may be represented in the model by carving. It is not essential to the success of the artificial palate that the posterior surface of the soft palate should be represented with the same accuracy that is required on the inferior surface or on both surfaces of the hard palate. By the aid of a small mirror and a blunt probe the thickness of the velum and the depth behind the fissure can be ascertained; approximate accuracy is sufficient, since the portion of the artificial palate coming in contact with it is so elastic that it easily adapts itself to a slight inequality, rendering absolute accuracy less important.

The next step will be the formation of a model or pattern of the palate. Sheet gutta-percha is preferable for this purpose, although wax or some other plastic substance might answer. The form which should be given is better indicated by the drawing, Figs. 1225 and 1237, than it could be by written description. The Stearns instrument, of which a cut is here given (Figs. 1233 and 1234), was made to embrace the edges of the fissure and was slit up through the middle, so that when the edges of the fissure approached each other, as they always do in swallowing, the two halves of the instrument would slide by each other; a third flap or tongue was made and supported by a gold spring, to cover and keep closed this central slit.

Fig. 1232 shows Dr. Kingsley's original artificial velum, conceived to meet the requirement for a more simple contrivance than the complicated Stearns instrument. It is said that Dr. Stearn before his death abandoned his complex apparatus, and was wearing one made upon the same plan as Dr. Kingsley's.

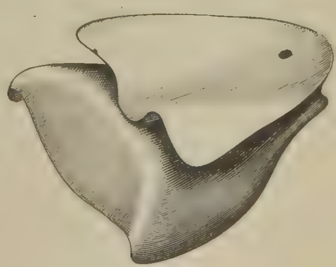

FIG. 1232.

Stearn's complicated provision for the contraction of the fissure is entirely superseded in Figs. 1225 and 1237 by making the instrument somewhat in the form of two leaves, one to lie on the inferior and the other upon the superior surface of the palate, and joined together along the median line. When the fissure contracts, the halves of the divided

uvula slide toward each other between these two leaves. The posterior portion, marked A, in Fig. 1225, is made very thin and delicate on all its edges, as it occupies the chamber of the pharynx, and is subject to constant muscular movement. The sides are rolled slightly upward, while the posterior end is curved downward. The inferior portion, marked D, D, should reach only to the base of the uvula, and bridge directly across the chasm at this point (Fig. 1226); and no effort to imitate the uvula should be made. The extreme posterior end should not reach the posterior wall of the pharynx by a quarter of an inch when all the muscles are relaxed (although subsequent use must determine whether to increase or diminish this space), thus leaving abundant room for respiration and for the passage of nasal sounds. In cases

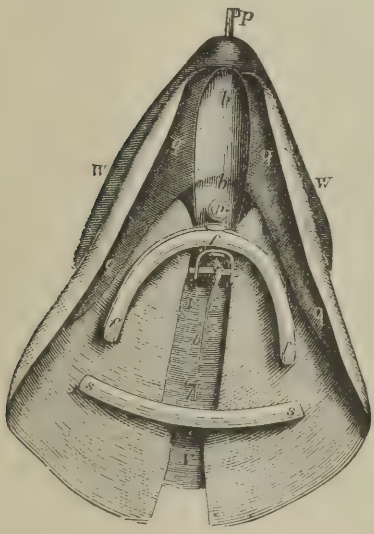

FIG. 1233.

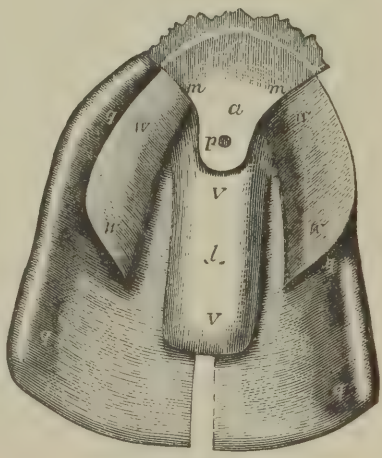

FIG. 1234.

where it is desirable to make the instrument, as far as possible, independent of the teeth for its support, the anterior part which occupies the apex of the fissure in the hard palate may lap over upon the floor of one or both nares. Such a projection is seen in Fig 1225, marked B, and a like process is seen in Fig. 1237, but not lettered. Were it not for this process in the first case, the palate would drop from the fissure into the mouth, the single clasp at the extreme anterior edge not being sufficient to keep the whole appliance in place throughout its entire length. Caution must be exercised that this projection entering the nares be not too large, or it will obstruct the passage, and give a disagreeable nasal tone to the voice.

All the peculiarities described must be provided for in the gutta-percha model, which after having been carefully formed upon the cast, may be tried in the mouth, to ascertain its length or necessary variations. When its ultimate form has been determined, provision must be made to duplicate it in soft rubber. A familiar illustration of the process here to be adopted is found in the parallel process employed when a set of teeth is made on the vulcanite base. A model form is made of wax and gutta-percha, bearing the teeth, and in all its prominent characteristics has the shape desired in the completed denture, the rubber duplicate being vulcanized in a plaster mold. In like manner the rubber duplicate of the palate, as before described, may be made in a plaster mold.

If plaster is used for the molds, it must be worked so that the surface shall be free from air bubbles, or the rubber palate will be covered with

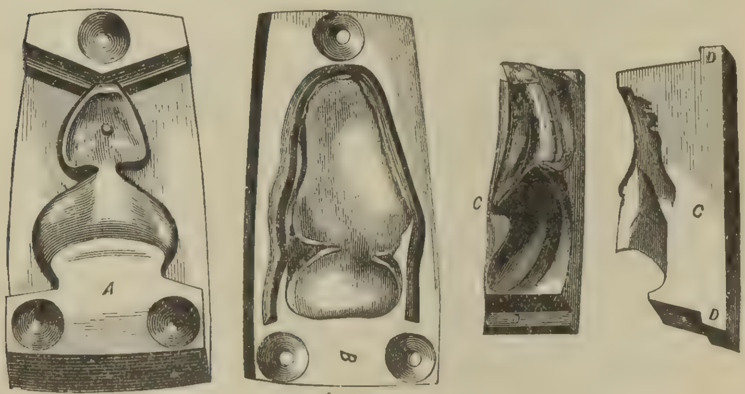

FIG. 1235.

excrescences that cannot readily be removed. By covering the surface of the mold with collodion or liquid silex, it will be much improved. But, ordinarily, plaster molds will be found too troublesome for general use. They may be put to a most excellent use, however, by using one to make a duplicate of the gutta-percha in hard rubber. This is not necessary with those who have had much experience, but with beginners it will be difficult to work up the gutta-percha as nicely as may be desired; a duplicate in vulcanite will enable the operator to make a more artistic model of the palate, and one which can be handled with greater freedom.

As in the course of a lifetime a considerable number of elastic palates will be required, the mold which produces them should be made of some durable material. The type metal of commerce is admirably adapted to this use. A very complete mold is one made of

four pieces which will produce a palate in one continuous piece. Such a mold requires very nice mechanical skill in fitting all the parts accurately, and unless the operator has had experience in such a direction it is better to simplify the matter. Fig. 1235 shows a mold in four pieces. The blocks, C, C, are accurately adapted to the body of the mold marked A, and are prevented from coming into inaccurate contact with each other by the flanges, D, D, which overlap and rest upon the sides of the main piece. B, shows the top of the mold, and the groove, E, provides for the surplus rubber in packing. Such a mold makes as perfect an appliance as can be produced. The palate is one homogeneous and inseparable piece. The cut will sufficiently indicate the form of the several parts. Each of these pieces is first made in plaster, having exactly the form desired in the type metal. They are then molded in sand, and the type metal cast as in making an ordinary die for swaging. When in use a clamp similar to Fig. 1236 is placed around the mold to keep the several parts firm in their position.

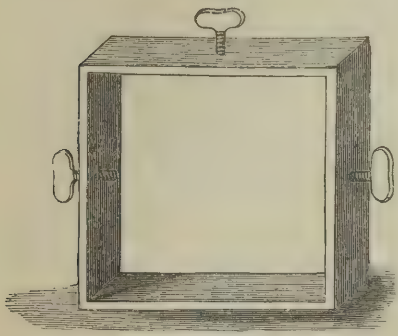

FIG. 1236.

Fig. 1237 shows the palate complete with its attachment to the teeth. The palate is secured to the plate by a pin of gold passing

FIG. 1237.

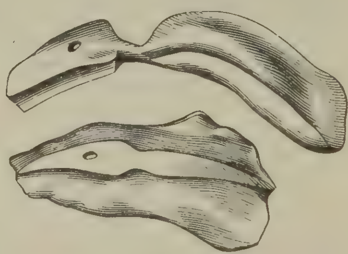

FIG. 1238.

through a hole of the same size in the palate, the head on the pin being larger than the hole through which it is forced.

By making the palate in two pieces to be joined after vulcanizing, as shown in Fig. 1238, the mold may be made in only two pieces and with very little trouble. When in use the two pieces, as here represented, are bound together at the forward part by the gold pin

before referred to, and a few stitches of silk secure it at the posterior part.

The instrument then becomes identical with that shown in Fig. 1237.

Fig. 1239 shows the mold or flask in which it is vulcanized. These flasks were made expressly for this purpose; but they are not so unlike the flasks in common use in dentists' laboratories that the latter will not answer. The common flask is simply unnecessarily thick or deep.

The mold is readily produced in the following manner: Imbed the two pieces of the palate in the plaster in one-half of the flask; when the plaster is set and trimmed into form, duplicate it in type-metal by removing the palate, varnishing the surface, molding in sand, and casting. In making the sand mold, take a ring of sheet iron of the same diameter as the flask and three or four inches high; slip it over

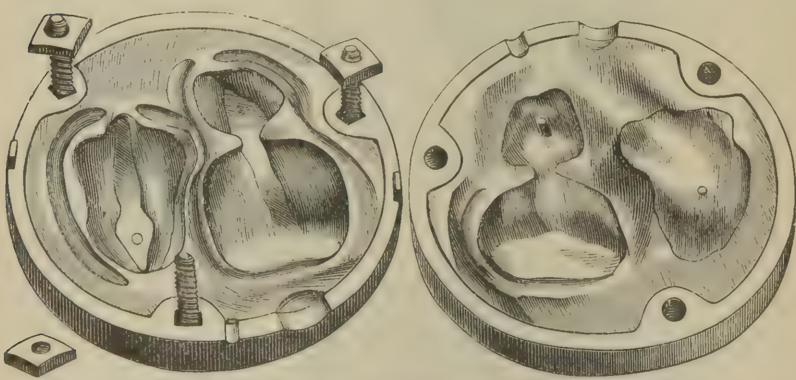

FIG. 1239.

the flask and pack full of sand. Separate them, remove the plaster, return the flask to the sand mold, and fill with the melted metal through a hole made in the side or bottom of the flask. Having thus made one-half, substantially the same process will produce the counterpart.

Fig. 1240 shows the mold which produces the palate illustrated by Fig. 1227. It is the most simple and at the same time the most complete of any mold yet invented. The mold is made in three pieces, and is inclosed in a flask exactly the same as Fig. 1239, but with this improvement: the latter mold yields a piece formed of two separate parts of rubber, which must be afterward joined by stitching or otherwise; while the former (Fig. 1240) produces an appliance in one piece, and as perfectly finished as by the more complicated mold of four pieces, shown in Fig. 1235. Letter A, represents the base of the mold;

B, the middle section, which is placed on the top of A ; and the third section, or top, C, completes it.

The mechanical process by which this mold is made is substantially the same as given for making those before described. The packing of the mold with rubber should be done in the same manner as when hard rubber is used for a dental base, with which process it is assumed that the reader is familiar. By washing the surface of the mold with

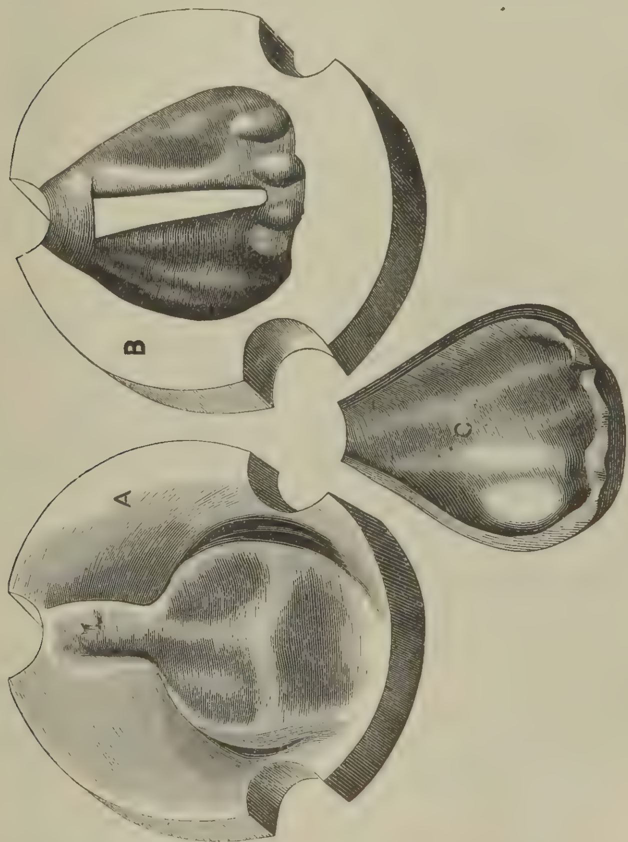

FIG. 1240.

a thick solution of soap previous to packing, the palate will be more easily removed after vulcanizing. The rubber used for this purpose must be a more elastic compound than that for a dental base-plate. The composition used for the elastic fabrics of commerce will answer, if made of selected materials. There is also on sale at the dental depots a soft, elastic compound admirably adapted to the purpose, with accompanying instructions for vulcanizing ; the best results being

obtained by heating up to 230°, and gradually increasing during four or five hours to 270°.

The following article on the treatment and education of Cleft-Palate Patients by Dr. Norman W. Kingsley is both interesting and instructive:*—

"The only necessity for interference, in congenital cleft-palate cases, is to remedy the defective speech.

"From time to time it has been asserted that the difficulties which the patient met with in deglutition would justify a surgical operation, but this is a mistake. Long before the child has reached maturity he has learned to accommodate himself to his unfortunate condition, and has acquired the habit of swallowing so well that it does not cause him embarrassment.

"There is no other evil attending cleft palate except the difficulty of articulate speech, and this does not lie in the fact that one *cannot* articulate, but only that his articulation is necessarily different from that of people who have normal organs of speech.

"The fault is not defective vocal organs, because the vocal organs are always as well formed, and in themselves as capable of perfect speech, as those of the rest of mankind. The difficulty arises from the inability of the patient to manipulate his voice in the production of the consonants, which form so large a part of spoken language. With the exception of intonation, the vowel sounds of articulate language are comparatively pure in these cases.

"The effect, however, of an inability to articulate many consonants renders the speech in some instances quite unintelligible, and in all cases very disagreeable. But if all people were born with cleft palates, there would be no defective speech. The speech of mankind would then be made without the introduction of certain consonants, which now form a distinguishing part of all languages. Thus we see that articulate speech is not a normal function, but an acquirement of man as he evolved from an original speechless condition.

"For treatment of congenital cleft palate both surgery and mechanism have been resorted to. Surgery was naturally first suggested. As operators became more and more skilled in their art, it was but reasonable to suppose that a complete surgical union of the split palate would cure the obvious evil. Staphylorrhaphy first became famous about the year 1820, through the skill of an American surgeon, Dr. Warren, of Boston. For many years thereafter the operation was regarded as one requiring unusual skill, and it became a favorite with ambitious surgeons desirous of distinction.

* *Dental Cosmos*, February, 1894.

"But surgery, after a full trial under the advantages of the most skilled artists for more than half a century, has disappointed expectations.

"The cases are very exceptional where normal articulation is ever acquired with a surgical velum. To understand the reason involves a knowledge of the mechanism of speech; a knowledge of the positions which normal organs assume in the formation of consonant sounds. The palate plays an important part in this function. It serves to close the passage to the nasal cavity and to the buccal cavity, and also to split the voice as it issues from the larynx. Each of these oper-

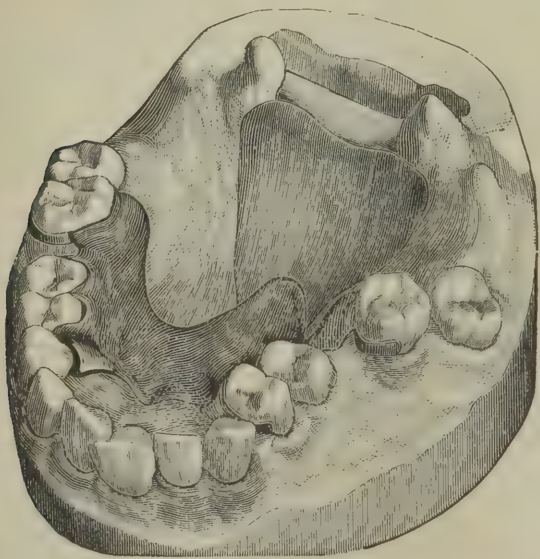

FIG. 1241.

ations changes the voice, thus producing different sounds, which form an essential part of all languages.

"The surgical palate is incapable of all these actions. In many instances it is so tense and so short that it appears to be more of an interference than a benefit. Besides, surgery is limited in its application. No prudent surgeon would attempt to operate without what he regarded as an abundance of tissue, with which to bridge over the gap. Thus are excluded a large number of cases involving extensive fissures of the hard palate, for which surgery can find no remedy.

"Mechanism, with all its objections, has produced the best results. Appliances are made sometimes flexible, or elastic, and sometimes rigid, or non-elastic. Flexible instruments have been made which

perform measurably the physical functions, and quite fully the physiological functions, of the natural velum. Rigid appliances (obturators), while not performing the physical functions, nevertheless, in many instances, perform the physiological functions of articulation equally well. Any one who has had long experience in making such

FIG. 1242.

instruments, and noting the effects of both sorts of apparatus, will have seen abundant evidence that *neither kind of instrument is the best in all cases.* Each has its advantages, and there are objections to the universal application of either.

"I make a distinction in name between the two kinds of appli-

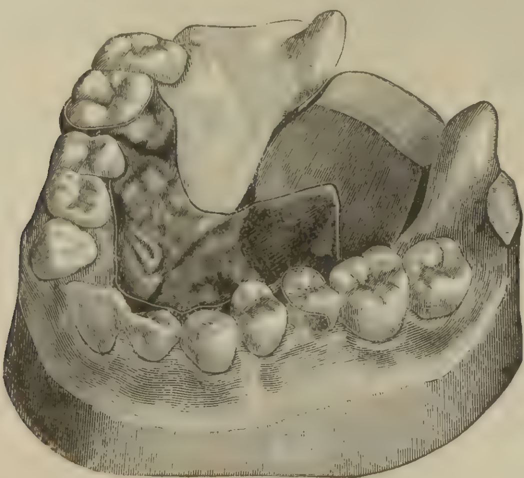

FIG. 1243.

ances. Flexible instruments are "artificial vela;" non-elastic instruments are "obturators." Figs. 1241 and 1242 show the former, Figs. 1243 and 1244 the latter.

"In the hands of a skillful artist of long experience, the flexible

instrument is undoubtedly the best with which to *acquire* articulation, and were it not for the perishable nature of the material of which it is made, there is no case in which it should not be preferred. It imitates the form and action of the natural velum quite as well as artificial teeth imitate the shape of natural teeth and perform the function of mastication, and with it one can learn to articulate more readily than with an obturator.

"Obturators are simply plugs filling up to a greater or less extent the upper pharynx or the posterior nares. When properly adapted they are especially valuable to supplement the use of an artificial velum, and in many cases their use would be justified as a primary instrument.

"No rule can be given, or description made, which will indicate to the inexperienced which sort of apparatus is likely to confer the most help in any case. No study of a model of the parts involved will be of much advantage. It is only the experienced eye, watching the action of the muscular tissues in the remainder of the palate and of the superior pharynx, which will guide to a determination.

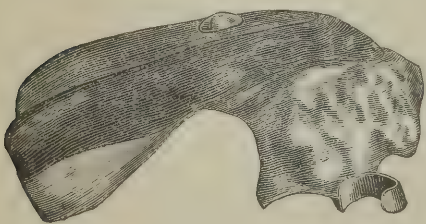

Fig. 1244.

"Nor is it at all possible, by observation of such action, to form any opinion of the effect upon the speech. That can be known only by hearing. With a personal experience of more than thirty years, and an observation of more than a thousand cases, I have failed to discover *all* the causes which are in force in producing mal-articulation. It is easy to discern physical causes, but the esoteric physiological causes are so remote that to me they still continue to be a mystery.

"I have seen horrible deformities in the absence of the velum, the hard palate, and all the anterior part of the alveolar arch, including also the upper lip, where the speech was absolutely unintelligible. Fig. 1245 represents the model of such a case. Here the inexperienced would readily find a cause for the mal-articulation. But I have seen very small clefts, fissures of the velum only, nasal passages normal, neither vomer, turbinated, nor palatal bones abnormal, and no harelip, where the speech was as defective as in the former case. Fig. 1246 represents one of the latter class.

"I have also seen an extensive fissure, involving hard and soft palates, a portion of the alveolar process, and a harelip, where but that the lip directed attention to the possibility of a palatal cleft, such

a deformity would not have been suspected from the speech, except by the most critical ear. For ordinary purposes of life, and to the aver-

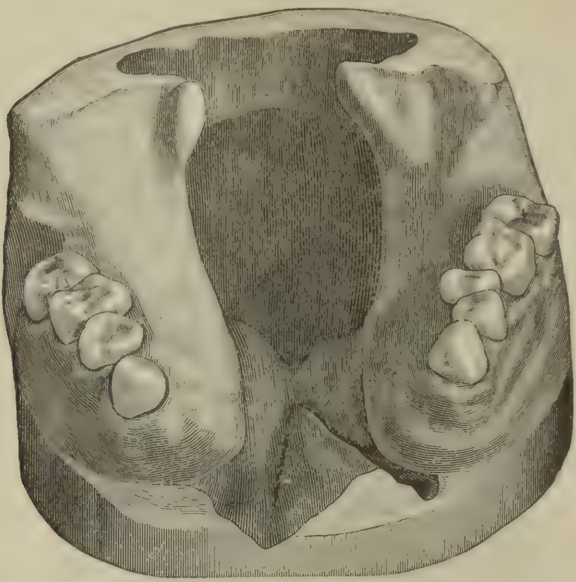

FIG. 1245.

FIG. 1246.

age listener, the speech was good. The only admixture was an occa-

sional guttural sound, which does not belong to pure English. Fig. 1247 is the model of that case.

"Where a cleft palate does not reach the alveolar border, there is no apparent anatomical reason why the sound of "s" should almost invariably be absent; but it is a fact; and there is every anatomical reason apparently in all clefts for the inability to form the sounds of "k" and "g;" yet I have heard these sounds made with great distinctness, *without an instrument*, and without special training. Such cases, however, are very rare. The possession of an apparatus, of whatever nature, however cunningly conceived and skillfully adjusted to the needs of the patient, will not transform him immediately into a

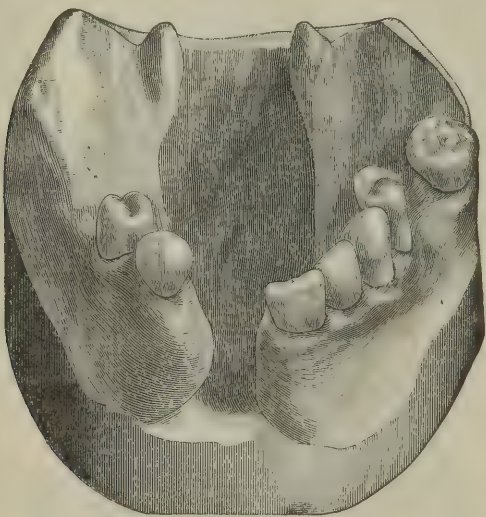

FIG. 1247.

perfectly speaking person, any more than would the possession of a violin transform the possessor into a master of that instrument.

"Articulate speech is an acquired function, and, being an acquirement, involves application and practice. An acquirement which so pre-eminently involves mental application must depend for its success largely upon the mental attitude of the applicant, and demands natural aptitude, as well as desire, determination, and perseverance. It is an imposition upon the credulity of this deformed class of people, undergoing constant mortification from their defect and terribly anxious for relief, to hold out the encouragement that they will certainly obtain relief by simply wearing an instrument. It is quite possible, and even probable, that if an instrument could be applied in infancy, the same faculty which enables the child to learn, without special instruction,

to speak with normal organs, would lead him to the same result with an artificial organ; but the people with whom we have to deal rarely come into our hands until early infancy has passed, and bad habits of speech have become almost fixed. The muscles involved in the mechanism of speech have acquired improper actions in their efforts to make up for their deficiency, and so it follows that the majority of people, upon the introduction of an artificial palate, are handicapped by the bad habits of speech which must be unlearned or overcome.

"After a somewhat lengthy experience, I am convinced that not more than one person in ten wearing an artificial palate (and I use the term now indiscriminately for both classes of instruments), having passed the age of childhood before its introduction, will *of his own volition* attain such perfection of articulation and enunciation that he does not betray his defect; while I also know that there are innumerable instances of persons who have reached mature age before they began their work of correction, who, *under proper instruction* and with perseverance, have attained absolute perfection.

"The imperative need of instruction was recognized by me in the earlier part of my practice, and from time to time I referred patients to teachers of elocution for help. The result was not always satisfactory. Most of such teachers placed more importance upon *elocution* than upon *articulation*, and although some of the pupils made wonderful progress in articulation, I was not altogether satisfied with the methods of instruction.

"For the last ten years or more there has been associated with me in my practice a lady who possesses, besides other accomplishments of education, a vocal and elocutionary training. She conceived the idea of formulating a system of teaching articulation to cleft-palate people which might be denominated 'a system of vocal gymnastics,' based upon the methods used in teaching elocution and in teaching deaf mutes to articulate. Her system is not one of fixed and rigid rules. It is not one that could be taught in books, but it is one of general principles, varied in its application to the idiosyncrasies of each case.

"As the result of having such an able coadjutor, of late years I have insisted that it would be almost useless for me to make an apparatus for any patient unless my work could be supplemented by proper instruction; and, furthermore, I have carried this denial to the extent of refusing to make an apparatus for any one whose apparent mental condition showed an incapacity for study and improvement.

"The results under such tuition as indicated have sometimes been rapid and marvelous.

"A lady, about twenty-five years of age, from a distant State, applied to me. She carried in her appearance evidence of intellect and good

breeding, but there was a certain hopelessness in her countenance, bordering on despair. Her case was not unlike many others, and, fortunately for her, there was no harelip to disfigure a rather handsome face. Her speech was the speech of the average cleft-palate patient, but she was very averse to talking, and brought a companion to speak for her. The arrangements were made for me to do my work, and for her to go under tuition.

"Before I had made much progress, her morbid condition impressed me so much that I spoke to her of it. I told her that to me it betrayed unmistakable evidence that she had no hope that she would receive benefit. She then told me that she had little or no faith in the result; that an effort had been made two or three times before, both by surgery and by mechanism, but all had failed; that she was of an exceedingly sensitive nature, and had avoided all society; that she had neglected her education because of her deformity; and that she had come to me as a final resort, with the determination that if this failed she would never return to her family, but would find some way to end all her troubles.

"I told her that it was almost useless for me to go on, unless she made an effort to throw off that condition and assume one of expectation of relief; that I could promise her, with absolute certainty, great benefit, if my directions were faithfully carried out.

"Suffice it to say that while at first she seemed incapable under tuition of comprehending what she was taught and directed to do, because her faculties had been dormant through neglected education, nevertheless she shortly began to rouse herself, and made progress.

"I lost sight of her for three months, during a summer's vacation, and on my return was astounded at the change. She was speaking exceedingly well, her face was brilliant with joy and gratitude, and she fully realized that there was something in life for her; that life was worth living.

"It has been generally supposed that a child with a congenital cleft must wait until the jaw and alveolar arch were pretty fully developed, or until about the twelfth year of age, before it was prudent to apply an artificial palate. I favored that idea myself many years ago, partly because I wished to avoid the annoyance to which the child might be submitted, and partly to save the expense of a second apparatus when the child should become older.

"My first use of such an appliance for a child was in January, 1865. It was for a boy eight years of age, who was nervous and irritable, and the results discouraged me.

"But the experience of many cases since has convinced me that my hesitation was a mistake. The advantages gained by an early inter-

ference far outweigh any financial considerations, and I find that children become accustomed to the presence of such a foreign body quite as readily as adults.

"The benefit to be gained by preventing improper efforts at articulation from becoming fixed habits, as well as the greater ease with which habits already formed can be broken up, must be manifest to every one. Children adopt involuntarily the tone of voice, accent, and peculiarities of utterance of those with whom they are associated, and I am satisfied that perfect results are attained more rapidly and with less effort by supplying an artificial velum early in life.

"A little girl seven years of age was brought to me. She had a harelip, which had been closed by a very fair operation, but leaving one nostril much more open than the other. I recommended a supplementary operation for reducing the size of that nostril, because I have found that an excessively open nostril, in such cases, makes articulation more difficult, besides altering the tone of the voice.

"For this child I made an artificial velum, and she was put under training. This training was an hour's lesson three times a week, the practice to be kept up under the care of her governess. The tuition continued for three months, after which the child was, by the removal of the parents, taken beyond the reach of her teacher. Within a year she was speaking quite as clearly as the children of her age, and the nasal resonance peculiar to such cases had entirely disappeared. During the following year, before she was nine years of age, her parents were spending the summer at a noted fashionable resort, and the child was placed in a select private school. She had learned to keep the fact secret that she was wearing an artificial palate, and her speech in nowise betrayed her. After a time her school-teacher came to her mother, and inquired if the child had ever had any special attention given to her enunciation, because, said she, "she speaks so much more clearly and precisely than other children, that I thought she must have had some special training."

"Another instance of a peculiarly interesting nature is that of a child six years of age. The model of this case is shown in Fig. 1248.

"I hesitated very much about undertaking this case, because of the difficulty of finding anything to which I could secure an artificial palate. The crowns of all the deciduous teeth in her mouth, except one, had decayed off level with the gums, and the first permanent molars had not erupted. But the mother of the child was persistent, and I made an artificial velum, clasping the fairly whole crown of a temporary molar on one side, and putting a gold crown on the remainder of its mate on the other side of the jaw, to which the second clasp was fitted. This child was for three months under the care of my teacher of articulation. She was formally given a short lesson

twice a day, and informally kept up a more or less continuous practice. She had never learned to read, not even knowing the letters of the alphabet. At the end of three months she could read simple lessons with ease, and her articulation was as faultless as that of the best children of her age. Previous to the beginning of this child's training her imperfect speech was recorded by a phonograph.*

"The next case, shown in Fig. 1246, is one of especial interest. The fissure is very small,—one of the smallest that I have ever attempted to treat. It would probably have encouraged the average surgeon to undertake an operation if he overlooked the fact which I have frequently pointed out,—viz, *that even with the gap in the velum perfectly closed there would still be a gap between it and the pharyngeal wall, which could not be bridged across except by an appliance; and,*

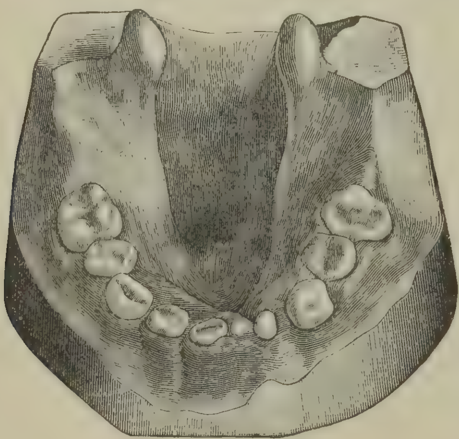

FIG. 1249.

furthermore, if the split in the velum were surgically closed, it would prevent the introduction of a suitable apparatus.

"In this case, notwithstanding the smallness of the fissure, the speech was about as bad as bad could be.

"This was a lad about ten years old, and to publicly prove his malarticulation I took him before one of the medical societies in New York, and submitted him to the following test: I gave to each person in the audience a piece of paper, upon which were thirty-four blank spaces numbered from one to thirty-four consecutively. I held in my hand a printed slip, on which were thirty-four words.

"I asked the lad to pronounce loudly, and with as much distinctness as possible for him, the word against each number as I pointed to it.

* At the time of this writing, one year after the introduction of the instrument, I have seen the child, and her speech is without defect.—N. W. K.

As he did so I requested the audience to write on the slips against the same number their interpretation of what they heard. The advantage of this test lay in the fact that the auditors had no clue to the coming words, and therefore were guided solely by their hearing. The lad was repeatedly asked to repeat the words, and in the end the slips written by the audience were compared with the printed slip held by me. Many of the records showed that not a single word had reached the writer correctly, and in no instance had more than five of the whole list been fully understood.

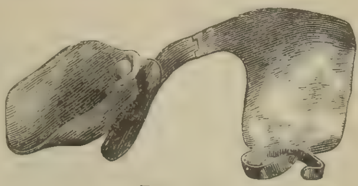

FIG. 1249.

"The instrument which I made for this lad is illustrated by Fig. 1249, and its position when in the mouth is seen in Fig. 1250. By an observation of Fig. 1246 it will be seen that the apex of the cleft is only about half-way from the uvula to the junction of the hard and soft palates.

FIG. 1250.

"To accommodate considerable vertical movement in the unruptured portion of the natural velum, the instrument is hinged at the posterior border of the palatal bone, so that ample provision is made for the vertical movement of the artificial velum. The hinge is supplied with a stop to prevent the velum from dropping below the fissure, but it can be carried upward with ease."

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